VERMONT STATEWIDE DIGITAL PARCELS RETURN ON INVESTMENT (ROI) STUDY

DRAFT V5

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www.AppGeo.com

24 School Street, Suite 500, Boston, MA 02108
Tel: 617-447-2400 ● Fax: 617-259-1688

Table of Contents

1 EXECUTIVE SUMMARY

The ownership of land is an aspirational goal of many people, and Vermonters who do own land know that it comes with the payment of taxes. The amount of taxes depends on how much land you own, and how its value is assessed. Key inputs to the assessment process are **property maps and ownership information, collectively known as parcel data.** Over the course of the past couple of decades, this data has been evolving from paper records to digital data, and municipalities are the authoritative source. The data is useful for many applications statewide besides taxation at the municipal level, including **economic development, public safety, and stormwater management** among many others.

These three particular applications of digital parcel data were used in this study to quantify the **benefits of accurate, current, consistent, and complete digital parcel data for the entire state**. These particular benefits, rather than the entire universe of potential benefits, were then compared to the **costs of transforming existing digital parcel data to a state standard, creating new digital parcel data where needed, and then maintaining this data over a five year period**. In dollar terms, the estimated costs for the 5-year recommended program are $2.3 million, and the expected benefits for the same period of time are from $6 million on the low side, to $12.9 million on the high side. Based on these low and high numbers, the resulting **ROI ratio ranges from a very conservative 1.58 to 4.55** for the recommended program**.**

Parcel data meets the criteria for being a public good, in that it is available to everyone by law (non-excluding) and the same data can be used by many people for many applications without diminishing the value to anyone else (non-rivaling). As a public good, **it is hard to compel free-riders to pay for the production or maintenance of parcel data**, unless they are required to pay for some compulsory reason, or willing to pay based on the outcome of a negotiation. The study team observed enthusiasm for and recognition of the qualitative benefits of statewide parcel data, but a general **lack of willingness to pay for a share of the costs**.

If only one agency contributes a fair share, and municipal government continues to fund existing efforts at current levels, there will not be **statewide standardized digital parcel data** made available for utilization across Vermont to enhance economic development, public safety, and stormwater management, to name a few of the key use cases. **State support and new investment is required**; otherwise, there is a real risk that the people of Vermont will not realize the benefits that would result from this contemplated program.

2 WHAT ARE STATEWIDE DIGITAL PARCELS?

The definition of parcels in the VT GIS Parcel Data Standard is as follows:

> *"Parcel data is the digital, geographically-referenced data used to represent parcel boundaries, un-landed dwellings, and associated attribute information on municipal tax maps."*

The standard also cites the definition of "parcel" in State Statute, which defines parcel as:

> *"…all contiguous land in the same ownership, together with all improvements thereon."*
> And, in the VT Parcel Mapping Guideline, it even says what it is not, in the context of GIS, and what it assists with, i.e.: *"GIS parcel data is NOT the equivalent of legal property records or land surveys, but the data does assist municipal officials with functions such as accurate property tax assessment, conservation, planning, and zoning."*

For the purposes of this ROI study, we are using the following definition of "Statewide Parcel Data":

- Consistent from town to town – follows VT GIS Parcel Data Standard
- Includes SPAN number to allow easy join to Grand List data
- Current – updated every year or two
- *Eventually – seamless data (lines up at town boundaries)*
- *Eventually – spatially accurate (will help towns tax equitably)*

3 THE VALUE OF DIGITAL PARCEL DATA

Consistent geospatial parcel data collected directly from local government is the most detailed source of property map information, and an excellent resource for understanding and detecting changes in population, housing patterns, forest cover, and land use. When combined with parcel attribution for ownership, property value, and land use, these data become a valuable resource for many purposes, for example: facilitating real property transactions and economic development; identifying areas with suitability for locating businesses or alternative energy facilities; visualizing financially distressed areas as an early warning indicator for policy-makers; estimating the scope of forest fragmentation; informing stormwater management policy, and numerous other use cases.

Parcel data are among the most versatile of any GIS data layer. As the below illustrates, a single set of parcel line geometry can be visualized in numerous ways. By shading parcels based on the assessed value, parcels becomes a property value data layer. By selecting the subset of parcels that are protected for open space, parcels become the protected open space data layer. When combined with elevation data, parcels that intersect with flood plains become obvious.

This versatility makes parcels an important element of a very large number of projects and activities that go beyond the raw efficiencies gained in parcel assessment, valuation and tax administration. When combined with other GIS layers, there is a synergistic relationship, and a multiplier effect on the value of other data when used in combination with parcel data.

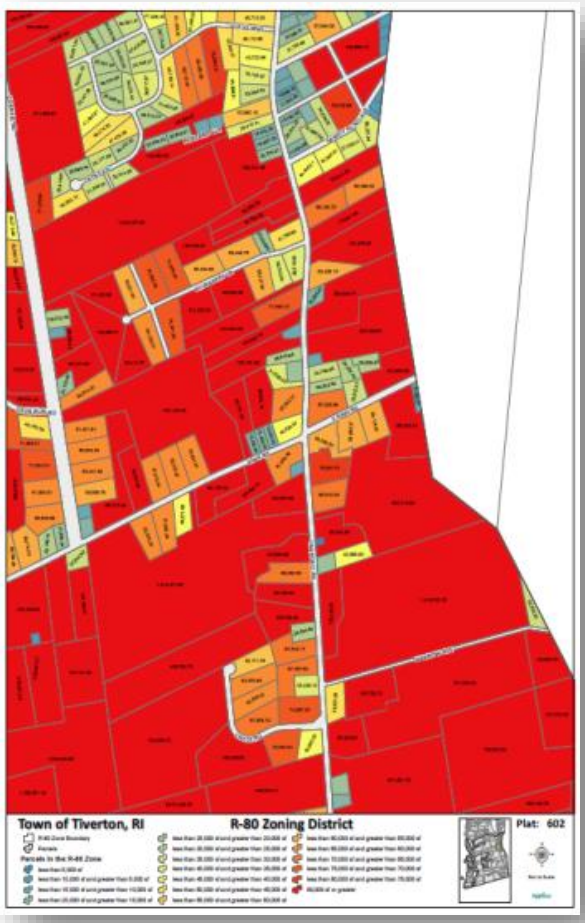


Figure 1. Zoning Map from Tiverton, RI based on color-coded digital parcels.

Vermont is not alone in pursuing statewide parcels to support a variety of needs and indeed there is a large amount of existing work that describes the benefits of statewide parcel data development.

- **Business Plan for Statewide Parcel Data Development & Maintenance for the Commonwealth of Massachusetts** (June, 2011)

- **New York State Business Plan for Centralized Access to Consistent Cadastral Data** (October, 2011)

- **Minnesota Geospatial Information Office, Business Plan for Statewide Parcel Data Integration** (September, 2012)

Several other statewide geospatial strategic plans have sections that call out the benefits of statewide parcel data, in particular:

- **State of Arkansas Geospatial Strategic Business Plan** (March 2010) - This plan addressed four priority "framework" data sets for the state, including parcels, and contained a specific discussion of the benefits that would be expected from parcel/cadastral data component.
- **Michigan Statewide GIS Business Plan** (August, 2010) - This plan addressed all "framework data" for the state but it included a specific discussion of the benefits that would be expected from parcel/cadastral data component.
- **Alaska Geospatial Business Plan** (February, 2012) - This plan discussed, and performed a return on investment assessment based on "framework data" which included, but was not limited to parcel/cadastral data sets.
- **State of Nevada Business Plan** (December 2013) – Business Plan focused on establishing a statewide geospatial coordination office to manage the effort of developing and maintaining statewide parcels.

4 BACKGROUND

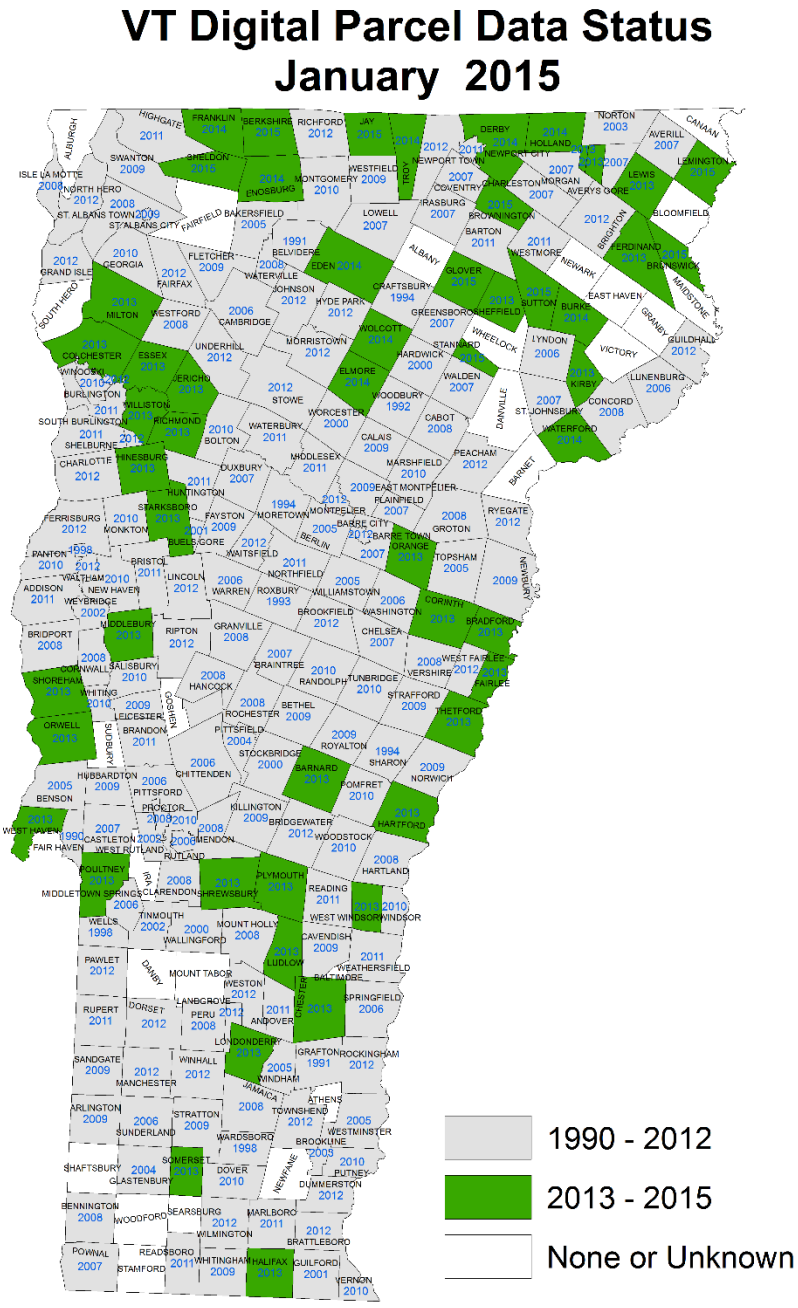
4.1 CURRENT SITUATION

The State of Vermont plans to complete the statewide digital framework that supports continuous, readily available, and comprehensive land-related information at the parcel level, including property maps and valuation data for taxation and equalization purposes. Much of the base map data, including roads, hydrography, and orthoimagery, is already in place. The missing element, in terms of seamless statewide coverage, is parcel data -- which does exist at the local level for most municipalities in the state, but is not developed to a consistent level of content, currency, or quality.

The Vermont Center for Geographic Information (VCGI) has recently compiled a statewide cadastral data set based on shapefiles submitted by Towns, villages and Regional Planning Commissions to serve as a general reference for parcel locations. While certainly a step forward in the goal of statewide parcels, the data quality varies by town, has many gaps and it is not necessarily up-to-date. There are also many municipal boundary issues present in the data as parcels do not match-up along the borders of neighboring towns. Nonetheless, many state agencies rely on this locally produced data, for a variety of applications. Some of the key use cases are described later in this report.

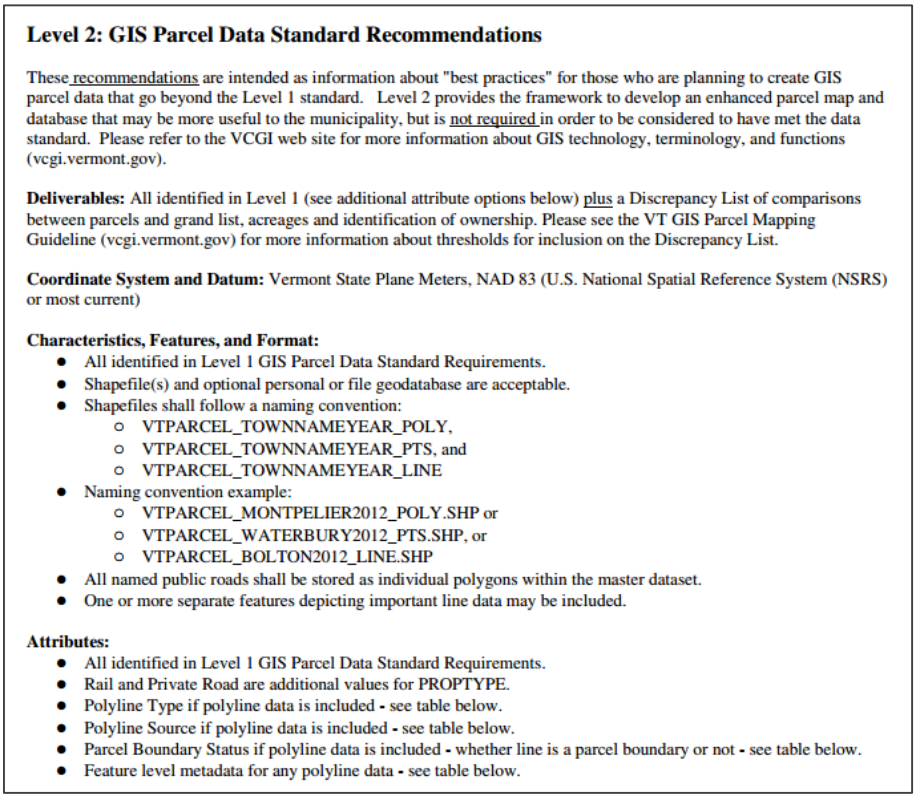
At the local level, most Towns can link their digital parcel maps to computer assisted mass appraisal (CAMA) data, including the Vermont Grand List published by the VT Department of Taxes, Division

of Property Valuation & Review (PVR). And so, the basic concept of a land or geographic information system (LIS/GIS) is well understood by most Towns, but the benefits have not been quantified, for the most part.



4.2 VERMONT GIS PARCEL DATA STANDARD

The Towns are the authoritative, official local source of such data, where parcel maps are part of the basis for property appraisal and taxation. To create a sustainable Statewide Parcel Data GIS layer, the Towns are key suppliers and maintainers of the parcels, but their local needs may not support a statewide approach (e.g. municipal boundary reconciliation). In November 2013, the Vermont GIS Parcel Data Standard was released by VCGI as Version 1.1. This standard is for developing and/or updating digital LIS/GIS versions of municipal parcel maps, and it is not intended for authoritative delineation of property boundaries, which requires a professional land surveyor. It has two levels of specificity: Level 1 describes the minimum elements of digital parcel data that are required *to ensure consistency* so that all town parcel data can be merged into a single statewide LIS/GIS layer; Level 2 is intended for an enhanced digital parcel map and database, but is not required for statewide integration. VCGI also provides shapefile and Geodatabase templates for use by Towns wishing to port their data into an existing, standardized format.



Level 2: GIS Parcel Data Standard Recommendations

These recommendations are intended as information about "best practices" for those who are planning to create GIS parcel data that go beyond the Level 1 standard. Level 2 provides the framework to develop an enhanced parcel map and database that may be more useful to the municipality, but is not required in order to be considered to have met the data standard. Please refer to the VCGI web site for more information about GIS technology, terminology, and functions (vcgi.vermont.gov).

Deliverables: All identified in Level 1 (see additional attribute options below) plus a Discrepancy List of comparisons between parcels and grand list, acreages and identification of ownership. Please see the VT GIS Parcel Mapping Guideline (vcgi.vermont.gov) for more information about thresholds for inclusion on the Discrepancy List.

Coordinate System and Datum: Vermont State Plane Meters, NAD 83 (U.S. National Spatial Reference System (NSRS) or most current)

Characteristics, Features, and Format:

- All identified in Level 1 GIS Parcel Data Standard Requirements.
- Shapefile(s) and optional personal or file geodatabase are acceptable.
- Shapefiles shall follow a naming convention:
  - VTPARCEL_TOWNNAMEYEAR_POLY,
  - VTPARCEL_TOWNNAMEYEAR_PTS, and
  - VTPARCEL_TOWNNAMEYEAR_LINE
- Naming convention example:
  - VTPARCEL_MONTPELIER2012_POLY.SHP or
  - VTPARCEL_WATERBURY2012_PTS.SHP, or
  - VTPARCEL_BOLTON2012_LINE.SHP
- All named public roads shall be stored as individual polygons within the master dataset.
- One or more separate features depicting important line data may be included.

Attributes:

- All identified in Level 1 GIS Parcel Data Standard Requirements.
- Rail and Private Road are additional values for PROPTYPE.
- Polyline Type if polyline data is included - see table below.
- Polyline Source if polyline data is included - see table below.
- Parcel Boundary Status if polyline data is included - whether line is a parcel boundary or not - see table below.
- Feature level metadata for any polyline data - see table below.

Figure 2. Excerpt from the Digital Parcel Standard document describing "best practices" for Towns wishing to develop an enhanced parcel map (Level 2).

4.3 THE ENTERPRISE GEOSPATIAL CONSORTIUM

Since the fall of 2013, representatives of state agencies, regional planning commissions, nonprofits (Vermont League of Cities and Towns), and professional organizations (Vermont Society of Land Surveyors, Vermont Assessors and Listers Association) have been meeting to discuss how to make consistent, up-to-date, statewide parcel data a reality in Vermont. That group eventually became the Enterprise Geospatial Consortium's (EGC) Parcel Workgroup.

The stated Vision for the EGC is:

> *"Coordinating state stakeholders and resources to develop a state-supported program in order to ensure the creation of municipal parcel data that meets the VT GIS Parcel Data Standard, is up to date, and will be updated regularly in the future."*

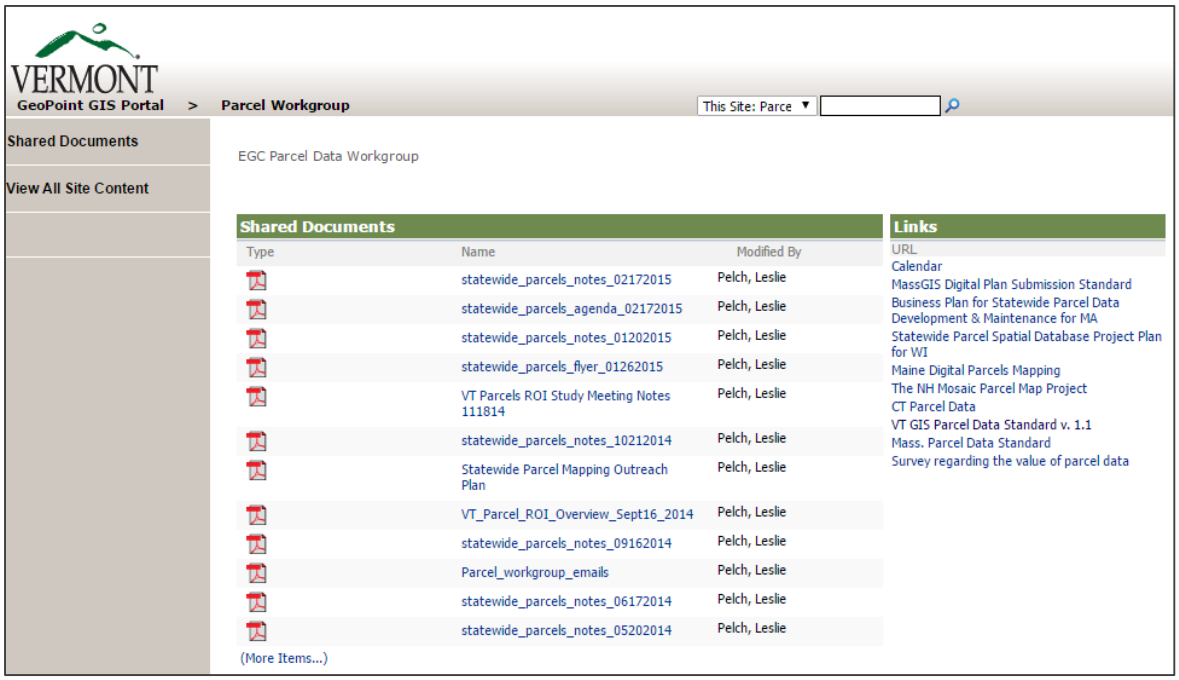


Figure 3. Documents and meeting notes can be found on the EGC Parcel Data Workgroup site: https://outside.vermont.gov/sites/egcgeo/parcelwg/default.aspx

5 OVERALL PROJECT APPROACH

In order to assess and document the value of Statewide Parcel Data in GIS format in quantifiable terms and produce results that provide business value and cost justification to decision-makers, the project team conducted extensive outreach to municipalities and other stakeholders to solicit their

perspectives about the value of parcel data. The study focused on a subset of specific use cases with particular statewide relevance. The project team identified a lengthy list of potential use cases, and prioritized three of these use cases for in-depth information gathering – Economic Development, Public Safety, and Stormwater Management. Input from stakeholders and subject matter experts informed the assignment of value to statewide parcel benefits for each use case.

Overall, the following steps were taken:

i. Identified potential quantifiable use cases that are relevant across the state and where digital parcels are part of an existing workflow, and picked three (3) for in-depth study and characterization: Economic Development, Stormwater Management, and Public Safety.

ii. Identified specific stakeholders for the prioritized use cases and gathered input on the value of statewide digital parcels. The project team, with input from the State, identified and contacted specific informants for each use case.

iii. Calculated benefits for each use case using Cost-Benefit Analysis (CBA) methodology.

iv. Combined the calculated benefits and statewide digital parcel costs into the ROI calculation.

5.1 STEP 1: IDENTIFIED POTENTIAL USE CASES AND SELECTED THREE FOR STUDY

Dozens of potential use cases were identified for statewide digital parcels. They are briefly described below, grouped under major subject areas:

1. **Economic Development**
    a. Accurate and complete site selection
    b. Reduced time hunting for property information
    c. Streamlined permitting

d. Improved ability to compete with neighboring states for new business
e. Frees resources to focus on incentivizing new business
f. Innovative uses of state land
g. Taxation and "Use Value Program" (including preferential treatment)
h. Site planning and development

2. Stormwater Management

a. Enforcement of Rights
b. Collection of Fees
c. Asset Management
d. Response to Inquiries and Complaints; Dispute Resolution
e. Identification of Parcels that drain onto State Land
f. Statewide and/or Watershed Land Use Mapping

3. Public Safety

a. Communication, Outreach & Information Gathering
b. Emergency Response
c. Disaster Recovery
d. Evacuation Planning
e. Environmental Health & Safety
f. Hazardous Spill Notification

4. Forestry

a. Support for forest products economy
b. Management of forest fragmentation and woodlot subdivision
c. Identification of land ownership
d. Improves accuracy and resolution of delineations
e. Support for tourism and recreation economy

5. Transportation

a. Communication and Information Gathering
b. Planning and Site Assessment
c. Data Maintenance and Asset Management
d. Innovative Uses of State Land
e. Enforcement of Rights
f. Environmental Health and Safety
g. Support for the Permitting Process
h. Owner identification

6. **General Municipal and Regional Entity Efficiency**
    a. Operational savings for code enforcement through reduced field visits
    b. Improved service to citizens
    c. Improved regional services to Towns
    d. Reduced time/effort in collecting and aggregating data at regional level
    e. Property valuation and identification of "comparable" properties

The following chart is a matrix of the potential use cases listed above, and the associated applications for statewide digital parcels.

Vermont Statewide Parcels Return on Invesment
Matrix of Sectors and Associated Statewide Parcel Data Uses

Sectors	Asset/Land Management	New Business Site Selection	Site Planning and Development	Streamlined Permitting	Improved Services	Forest Fragmentation/Parcelization	Support for Field Work/Inspections	Fair Taxation & Use Value Program	Communication and Outreach	Evacuation & Access Planning	Damage Assessment & Recovery	Collection of Fees	Identifying Encroachment	Response to Inquiries/Complaints	Tourism and Recreation	Land Use Mapping/Verification
Econ. Development	X	X	X	X	X	X		X	X			X	X	X	X	
Forestry	X		X		X	X	X	X	X				X		X	X
Tax Assessment	X	X	X	X	X	X	X	X	X			X	X	X	X	X
Stormwater	X		X	X	X		X		X			X	X	X	X	X
Pub Safety/Emerg Resp			X		X		X		X	X	X				X	
Transportation	X		X	X	X		X		X			X	X	X	X	X
Floodplain Mgt.			X	X	X		X		X			X	X	X		
Planning	X	X	X	X	X	X	X		X			X	X	X		
Land Surveying			X		X	X	X		X			X		X		X
Housing	X		X	X	X		X	X	X			X		X		X
Broadband Planning	X	X	X		X				X			X		X		

Application Use

Denotes sector and use case considered for ROI benefits
Denotes sector and use case considered as "sub-category" within primary area of ROI focus
X Denotes potential sector and use case example

Figure 4. Matrix of Sectors and Associated Statewide Digital Parcel Data Uses.

While the chart above demonstrates broad potential usage of a statewide digital parcel data set, this study focused in on three key use cases: Economic Development, Stormwater Management, and Public Safety. These uses cases were chosen for a number of reasons including the perceived high value to all levels of government as well as the private and non-profit sectors. For each of these areas, over half of the respondents to the online survey rated them as either "important" or "very important" to their job and this was echoed during the workshop discussions. These use cases, in particular, also demonstrate the need for a statewide data set as the benefits presented here are not realized with parcels only at the local level.

5.2 STEP 2: IDENTIFIED SPECIFIC STAKEHOLDERS FOR CONTACT

Outreach for each use case, including workshops and interviews with subject matter experts, was conducted by the project team.

Workshops were held in three locations:

- Rutland – 14 attendees
- Lake Morey – 19 attendees
- Winooski – 24 attendees

A broad range of stakeholders attended the workshops including representatives from:

- Cities/Towns (Listers, Assessors, Public Works, GIS Techs, Planners)
- Regional Planning Commissions,
- State Agencies (VTrans, ACCD, ANR, Taxes),
- Non-profits and educational institutions,
- Private Sector (GIS services, consulting foresters, land surveyors, real estate)

A complete list of interviews is provided as an Appendix to this report.

5.3 STEP 3: CALCULATED BENEFITS BASED ON INPUT FROM INTERVIEWS

Interviews were conducted based on use cases to develop quantifiable answers from respondents to inform benefit valuation. Examples of actual answers from the study include:

Cost Savings: "Currently hundreds of hours are spent researching property owners and abutters in support of Stormwater Management."

Better Results: "Complete and accurate statewide parcels would significantly improve the site selection tool bringing new businesses and new jobs to the State of Vermont."

Other answers across the set of case studies suggested cost avoidance (e.g. improved damage assessment) and revenue generation (e.g. fall foliage tourism) as additional benefits from the use of digital parcels. Procedures for identifying and reaching out to respondents included in-person and telephone interviews, and e-mail correspondence. Conservative dollar values were used by the team so as not to overstate the value of digital parcels for any particular use case.

5.4 STEP 5: COMBINED BENEFITS AND COSTS FOR ALL THREE USE CASES

The combination of benefits for all three use cases, and the associated costs for the statewide digital parcel program were processed to yield a Return on Investment (ROI) using Cost-benefit Analysis (CBA) techniques. These techniques produced a net present value (NPV) dollar amount, and the terms for the ROI equation (benefits minus costs, divided by costs), to derive the ROI ratio for the statewide digital parcel project.

The final worksheet result brings together all information collected and calculated for each use case, to compare project costs to benefits over a 5 year project period; and it outputs the final "Net Present Value" and "Return on Investment" ratio. A detailed explanation of Cost-Benefit Analysis methodology is provided as an Appendix to this report.

6 ESTIMATING STATEWIDE DIGITAL PARCEL PROJECT COSTS

The following images (next page) display the project costs based on the recommendations presented in the "Statewide Digital Parcel Maintenance & Lifecycle" report as well the costs for an alternative approach also presented in the "Lifecycle" report. These cost estimates include the development, coordination, operational, and maintenance costs over a 5 year period. It should be noted that the potential loss of existing jobs in not included as a cost for the alternative implementation approach nor is any cost assessed to the perception of a parcel maintenance "takeover" by the state. For more detail on the recommended and alternative implementation approaches, see the "Statewide Digital Parcel Maintenance & Lifecycle" report.

Vermont ROI for Statewide Parcels

Project Costs Worksheet (Recommended Approach)

Showing Estimated Five Year Cost and NPV Estimates (All Costs)

			Discount Rate = r =	**0.4%**	**NPV=**	$Cost_t/(1+r)^t$
			(1+r)=	**1.0040**	**t=**	{0,1,2,3,4}
t=	0	1	2	3	4	
COST ITEMS	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**TOTALS**
Data Development Costs						
Intial Development	$500,000	$500,000	$500,000			$1,500,000
Data Development Subtototals	**$500,000**	**$500,000**	**$500,000**			**$1,500,000**
Data Maintenance Costs						
Data Maintenance Costs		$63,155	$125,058	$189,483	$189,483	$567,179
Data Maintenance Subtototals	**$0**	**$63,155**	**$125,058**	**$189,483**	**$189,483**	**$567,179**
State Operating Costs						
Data collection	$9,097	$9,097	$9,097	$4,549	$4,549	$36,389
Data extract, transform, load	$10,652	$10,652	$10,652	$5,681	$5,681	$43,318
Quality assurance	$27,291	$13,646	$13,646	$7,278	$7,278	$69,139
State outreach, education, coordination	$13,646	$13,646	$13,646	$7,278	$7,278	$55,494
RPC project management	$23,000	$23,000	$23,000	$0	$0	$69,000
Operating Subtotals	**$83,686**	**$70,041**	**$70,041**	**$24,786**	**$24,786**	**$273,340**
TOTALS:	***$583,686***	***$633,196***	***$695,099***	***$214,269***	***$214,269***	***$2,340,519***
NPV:	**$583,686**	**$630,673**	**$689,571**	**$211,718**	**$210,875**	***$2,326,524***

Figure 5. Estimated project costs based on recommended approach

Vermont ROI for Statewide Parcels

Project Costs Worksheet (Alternative Approach)

Showing Estimated Five Year Cost and NPV Estimates (All Costs)

		Discount Rate = r =	**0.4%**		**NPV=**	$Cost_t/(1+r)^t$
		(1+r)=	**1.0040**		**t=**	{0,1,2,3,4}
t=	0	1	2	3	4	
COST ITEMS	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**TOTALS**
Data Development Costs						
Intial Development	$500,000	$500,000	$500,000			$1,500,000
Data Development Subtototals	**$500,000**	**$500,000**	**$500,000**			**$1,500,000**
State Operating Costs						
Data collection	$9,097	$18,194	$18,194	$22,743	$22,743	$90,971
Data extract, transform, load	$10,652	$10,652	$10,652			$31,956
Annual Maintenance	$0	$31,032	$62,881	$81,664	$81,664	$257,241
Quality assurance	$36,388	$13,646	$13,646	$13,646	$13,646	$90,972
Ongoing outreach, education, coordination	$13,646	$13,646	$13,646	$36,389	$36,389	$113,716
Operating Subtotals	**$69,783**	**$87,170**	**$119,019**	**$154,442**	**$154,442**	**$584,856**
TOTALS:	***$569,783***	***$587,170***	***$619,019***	***$154,442***	***$154,442***	***$2,084,856***
NPV:	**$569,783**	**$584,831**	**$614,096**	**$152,603**	**$151,995**	***$2,073,309***

Figure 6. Estimated project costs based on alternative approach

7 ESTIMATING STATEWIDE DIGITAL PARCEL BENEFITS

The final worksheet brings together all information collected and calculated in the previous worksheets to compare project costs to project benefits over the 5 year period, and outputs the final "Net Present Value" and "Return on Investment" ratio. There is only a single input on this worksheet for "Discount Rate", which is used to discount future costs and benefits into the present context. The discount rate can be determined using the following table. In the context of this analysis, which is based on 5 years, the real discount rate (adjusted for inflation) is 0.4%.

Use Case Benefits Summary Worksheet						
Showing Estimated Benefits Based on Actual Use Cases						
			Discount Rate = r =	**0.4%**	**NPV=**	$Benefit_t/(1+r)^t$
			(1+r)=	**1.0040**	**t=**	{0,1,2,3,4}
t=	0	1	2	3	4	
USE CASES "LOW" BENEFIT VALUES	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**TOTALS**
Stormwater	$ 235,200	$ 235,200	$ 235,200	$ 235,200	$ 235,200	**$1,176,000**
Economic Develoment	$ 809,213	$ 809,213	$ 809,213	$ 809,213	$ 809,213	**$4,046,065**
Public Safety	$ 166,000	$ 166,000	$ 166,000	$ 166,000	$ 166,000	**$830,000**
TOTALS:	***$1,210,413***	***$1,210,413***	***$1,210,413***	***$1,210,413***	***$1,210,413***	***$6,052,065***
NPV:	**$1,210,413**	**$1,205,591**	**$1,200,787**	**$1,196,003**	**$1,191,239**	**$6,004,033**
USES CASES "HIGH" BENEFIT VALUES						
Stormwater	$ 465,200	$ 465,200	$ 465,200	$ 465,200	$ 465,200	**$2,326,000**
Economic Develoment	$ 1,618,426	$ 1,618,426	$1,618,426	$1,618,426	$1,618,426	**$8,092,130**
Public Safety	$ 520,000	$ 520,000	$ 520,000	$ 520,000	$ 520,000	**$2,600,000**
TOTALS:	***$2,603,626***	***$2,603,626***	***$2,603,626***	***$2,603,626***	***$2,603,626***	***$13,018,130***
NPV:	**$2,603,626**	**$2,593,253**	**$2,582,921**	**$2,572,631**	**$2,562,381**	**$12,914,812**

Figure 7. Statewide parcel data use case benefits summary table

7.1 STUDY OBSERVATIONS

7.1.1 PARCEL DATA AS A PUBLIC GOOD

Parcel data in Vermont meets the economic criteria for what is a public good, i.e., its utilization characteristics are non-excluding and non-rivaling. It is non-excluding because parcel data are open records, and it is not legal to prevent anyone from rightful access. For all reasonable intents and purposes, parcel data must be publicly provided. It is non-rivaling because one person or agency user does not preclude another person or agency from also using it at the same time, in contrast to maple syrup!

In the absence of market mechanisms for valuing a public good, inadequate production and maintenance of parcel data is likely to occur to meet statewide demand without state support. In the absence of state support, the people of Vermont will forgo the net benefits that would result from complete, standardized digital parcel data made available for utilization all across Vermont and beyond its borders. The question is, where will government funding come from to finance the public provisioning of such parcel data?

7.1.2 THE MARGINAL COST AND BENEFIT OF PARCEL DATA

More than one person or agency can benefit from a given supply of parcels simultaneously, at least in theory. A person using it for a forestry application, for example, doesn't diminish its value to someone who wants to use it for a store locator application. If parcel data are provided to one person or agency user, it should be provided to all users. The marginal cost of supplying each new user is essentially zero, especially with modern Internet-based distribution. In fact, it would be economically inefficient to exclude additional increments of users. Allowing non-excluding broad use by many users is rational utility maximization, which increases ROI and the positive net benefits for a public good, as benefits accrue at no-charge to users and virtually no marginal costs to add users. In socio-economic terms, this can also be viewed as a Pareto-improvement, where there are gains and no losses.

In Vermont, there is already a substantial investment that has been made in parcel data, and that continues to be made by towns across the state. From the study, it is clear that there is a perception of positive net benefits already – otherwise, the towns wouldn't do it. But the towns are primarily focused within their own jurisdictional boundaries, and demands on them to conform to a state standard to benefit the state need some level of additional state funding to finance the conformance effort. If the state was to leverage the existing investment made by the towns by adding funds to finance the editing of parcel data to match a state standard, and for maintaining the parcel data in conformance with the standard, Vermont would have the consistent and current data that it needs. From an economic standpoint, the marginal cost of achieving this is far less than funding the effort from scratch. For towns that currently have digital parcel data, the cost to achieve conformance is, on average, around $2,000.

7.1.3 VALUING PARCEL DATA AND THE FREE-RIDER PROBLEM

Certainly there are social considerations not reflected in markets, but market prices are the most readily available indicator of people's "willingness to pay" (WTP) for something. But since parcel data are a public good, there is no market mechanism that causes users of parcel data to reveal their WTP, and there is no "market price" for parcel data. If a person or agency has no incentive to reveal their true perception of the value of parcels in the absence of prices, but intend to use the data without paying because they can, then a free-rider problem exists. **Given that a public good is non-excluding, it is hard to compel free-riders to pay, unless they are required to pay for some compulsory reason of policy, or as the outcome of a negotiation.**

If one agency -- or one level of government, such as Towns (who are the current source of parcel data) -- pays for all of the production and maintenance costs of complete, standardized parcel data for the entire state, there is a very strong likelihood of continuing the free-rider problem.

Theoretically, the agencies should be able to work out the free-rider problem by negotiating fair contributions that are commensurate with expected utilization and ability to secure funding – easier said than done. There certainly are some towns and agencies that are less able to contribute than their counterparts, and it is a government responsibility to candidly recognize and address such conditions, and it has in Vermont – for example, VCGI has provided grants to towns in needy parts of the state, to help finance the cost of parcel production. The grant funding came from the Northern Border Regional Commission and is not recurring, so there is a sustainability issue, and cost.

7.1.4 WHO WILL PAY, HOW MUCH, AND GAME THEORY

Who will pay is different from willingness to pay (WTP). As an example of WTP in this context, during one of the workshops a representative from an engineering firm said his company would probably be willing to pay for parcel data if it saved them money. But for what is in essence a public good, a commercial entity's WTP is not as straightforward as it might appear, and can result in demand rationing of social surplus, limiting utilization to those WTP, rather than a policy of non-excluding utility maximization. In other parts of the country where this has been tried as a means for cost recovery (e.g., Pima County, Arizona, and Denver County, Colorado), it resulted in very few people having access to the parcel data, and the companies that purchased it folded the costs back into the prices they were charging the public agencies and citizens for work that utilized the parcel data. This came to be recognized as an unintended economic consequence with negative social benefit, and was discontinued.

Game theory applies when agencies who are actually willing to contribute something hold-off until others contribute, even if it leads to a stalemate. It is also at work when there is strategic bias or gamesmanship applied, i.e., when agencies are willing to pay for part of the costs, but "not more than their fair share" based on not revealing the true value they put on parcel data, regardless of how they actually value it in real use. This makes it difficult to estimate the full value of parcel data based on asking for people's WTP.

There are agencies in the state that could potentially contribute to statewide parcel data, but who do not pay (or will not pay), because they assume someone else will take care of it, and that they will still benefit. This classic problem with public goods is largely attributable to their non-excluding trait, and it is actually rational economic behavior when self-interest is paramount, or when the belief is that paying for parcels will come at the expense of something else – many people and agencies are both self-interested and loss averse, but there are also those who will do whatever they can to move this statewide parcel initiative forward.

7.1.5 OPPORTUNITY COST

With opportunity cost, the relevant outlook is toward what would be given up today and in the future for one course of action in comparison to an alternative. For example, if Vermont put the same amount of funding that is required to achieve parcel data conformance to a standard for the entire state into a different alternative, what might that be and what would the net benefits be compared to investing in parcel data? This study has not specifically compared the opportunity cost for developing statewide digital parcels to actual alternatives for spending the same amount of money. If alternative uses were to be compared, evaluating their estimated ROIs would be one basis for comparison. However, since it is not common for other state programs to have a well-documented ROI, using the same standard methodology and conservatism for consistency, the economic basis for comparison is lacking in Vermont.

8 USE CASES

8.1 ECONOMIC DEVELOPMENT USE CASES DESCRIBED

According to the "Vermont 2020: Comprehensive Economic Development Strategy[1]", completed in June 2014, Vermont is poised to become a stronger and more prosperous state in the coming decade.

Category	Use Case
Vermont Business Recruitment/Development	Accurate and Complete Site Selection Tools; Reduced time hunting for information
	Streamlined permitting process
	Innovative uses of state land
	Frees resources to focus on incentivizing new business
Managing Forest Fragmentation	Support forest products economy
	Tourism and Recreation
Current Use Program Management	Improved verification process; potential for enforcement
	Ability to analyze ratios and see trends statewide
	Fair and equitable taxation

[1] http://accd.vermont.gov/business/strategic_planning

This important growth will not be without challenges however, and statewide digital parcels will help the state overcome some key barriers to economic success.
Important areas of economic development the use cases supported by digital parcels are presented in the table above. These are discussed in more detail below.

8.1.1 NEW BUSINESS SITE SELECTION

The statewide comprehensive economic strategy report names several key strategies for success in Vermont, including “Creating a competitive business environment". This is challenging for a number of reasons. Neighboring states such as New Hampshire and New York offer tax incentives to new businesses that make those locations more appealing. Also, the supply of available sites in Vermont for larger companies is very small. Most relevant to the parcel initiative is the fact that the current site locater tool, aimed at helping new businesses easily find sites that meet their criteria, is incomplete and inaccurate. This information, for the most part, is in people’s heads and cannot be discovered easily.

Figure 8. Photo credit: http://digital.vpr.net/post/manufacturers-want-dispel-job-stereotypes

Figure 9. Photo credit: http://www.gadoodles.com/images/ME-NH-VT/Vermont/CabotCheeseFactory/

Statewide parcels would provide a key tool for economic development and business site selection consultants. When businesses or their site selection consultants are looking for properties, it is critical that they be easily able to view property boundaries and key characteristics of the parcels such as the current assessed value or current land uses. Of equal importance can be information on abutting properties such as the number of neighbors a given parcel may have. States that have their parcels

completed and available through a site locater tool have a distinct advantage in this arena.

The "Vermont 2020: Comprehensive Economic Development Strategy" report, identifies economic cluster areas for the state that are projected to have strong job growth in the coming years. For the purposes of quantifying the potential impact of statewide digital parcels on this growth through improved site selection, the project team focused on clusters that would likely be most impacted including:

- Computer Systems Design and Related Services
- Community Care Facilities for the Elderly
- Coffee and Tea Manufacturing
- Supermarkets and Other Grocery
- Navigational, Measuring, Electromedical and Control Instrument Manufacturing
- General Warehousing and Storage

For each of these clusters, the projected job growth by 2023 was increased conservatively by 1% to measure potential impact of digital parcels. The additional 1% increase was valued with the project per capita income of $30,566 to arrive at a total job value by 2023. This number was then divided by 7 to arrive at a "per year" job growth value.

The table below shows the potential new jobs created by improved site selection with the availability of statewide parcels.

2013-2023 Projected Growth - Economic Clusters	Potential New Jobs by 2023	$ Value of New Jobs
Computer Systems Design & Related Services	39	$ 1,197,575
Community Care Facilities for the Elderly	22	$677,953
Coffee and Tea Manufacturing	14	$433,731
Supermarkets and Other Grocery	81	$2,486,849
Navigational, Measuring, Electromedical and Control Instrument Manufacturing	18	$551,104
General Warehousing and Storage	10	$317,275
Total Potential Value in 2023	**185**	**$5,664,491**

8.1.2 INNOVATIVE USES OF STATE LAND

Site screening for potentially locating alternative energy projects, such as solar panels would benefit from access to statewide parcel data. The following example, while specific to VTrans ROW lands, has relevance to other state agencies, especially since not all of VTrans-owned lands are along ROWs – they own parcels that are off-corridors, and are potential project sites for innovative uses of state land, too. Knowing about the parcels that surround VTrans-owned parcels – or any other state-owned lands -- would be valuable to the screening process for potential uses, such as:

- Ownership
- Land use (and conflicting uses)
- Land cover (such as shading trees)
- Access and safety
- Physical characteristics (structures, drainage, utilities)
- Solar energy potential

In addition to alternative energy siting, other alternative uses of statewide parcels in conjunction with ROW parcels, which could have economic benefit potential, include:

- Carbon sequestration and biomass
    - Wood
    - Grass
    - Feedstocks
- Habitat development
- Utility corridors

Some of the considerations include identifying parcels adjacent to ROWs that might be synergistic and compatible with the above-mentioned alternatives. For example, farmland adjacent to a VTrans ROW could present beneficial opportunities for farmers wanting permits to harvest grass from the VTrans land. Questions that might arise from this scenario, which could be answered with queries on statewide parcels, might include:

- Who are the farmers?
- How much contiguous land do they own?
- What are they currently growing?
- Distance to market?

8.1.3 STREAMLINED PERMITTING PROCESS

Parcel data are essential to the permitting process for identifying proximity to regulated areas, relevant features or buffer zones as well as notifying abutters to a project. Parcels would also aid in determining whether the need exists for a second access permit. Contractors spend time and budget hunting down parcel data from various sources, converting data to a usable format, or even digitizing parcel data on a case by case basis. These activities and costs would be significantly reduced with statewide, standardized parcels.

8.1.4 FOREST FRAGMENTATION AND WOODLOT SUBDIVISION

In April of 2015, the Vermont Department of Forests, Parks and Recreation published the "2015 Vermont Forest Fragmentation Report," for the Vermont Legislature. It validated what the Parcel study team had heard in interviews, i.e., that forest fragmentation was an issue with a high correlation to parcel data. As stated in the report: *"Subdividing forests into lots for house sites or other types of construction fragments Vermont's forests and reduces their value as wildlife habitat and a forest industry resource, as well as diminishes Vermont's tourist economy."*[2]

The general consensus is that Forests and Parks has a good handle on its state-owned lands, but 80% of Vermont forests are owned by individuals and families. This makes measuring the scope of forest fragmentation complex and difficult. And as a "rule of thumb," the smaller the parcel, the

[2] "2015 Vermont Forest Fragmentation Report," Vermont Department of Forests, Parks and Recreation, Agency of Natural Resources, April 2015, p.1.

harder it is to have managed forests, whereas the larger the parcel, the greater the likelihood of managed forests.

Forest fragmentation is the breaking of large, contiguous forested areas into smaller pieces of forest. Closely related to, but different from fragmentation is the process of **parcelization**. Parcelization is the legal process whereby large tracts of land are divided into smaller ownerships or land holdings (i.e., subdivisions) that often promotes new infrastructure development (e.g., roads, utilities, septic units, residential and commercial buildings). When this happens on forested landscapes, it leads to forest fragmentation. There are many causes of parcelization and forest fragmentation in Vermont, including:

- Escalating land prices
- Increased property taxes as land and property valuations go up
- Conveyance of land from aging landowners (e.g., bequeathing land to multiple heirs)
- Exurbanization (i.e. the migration of urban residents to rural environments)

Source: "2015 Vermont Forest Fragmentation Report," ANR, Forest, Parks and Recreation, p.23.

There is general recognition that Forest fragmentation is an issue in Vermont, but there is not general agreement on the scope of the problem statewide. It is currently difficult to directly measure the scope of the issue, in part due to the difficulty of accurate, current, and complete digital parcel data for the entire state. Foresters currently use indirect quantification methods to estimate the scope of forest fragmentation, such as[3]:

- The amount of forest edge versus interior forest
- Proximity to roads
- Forest patch size
- Local human population density
- Inter-mixed house densities

The foresters who were interviewed for the ROI study thought that comprehensive statewide parcel data would be nice to have, but not necessarily critical to perform their jobs. However, there was general agreement that such data would allow for statewide issues such as forest fragmentation to be better measured, and tracked over time much better with accurate, current, complete digital

[3] Ibid., p. 27.

parcel data – which could be integrated with other statewide layers for a more holistic view that could produce new insights to ways to better manage the issue of forest fragmentation. Paraphrasing management thinker Peter Drucker (deceased), who generally gets credit for this saying, "You can't manage what you can't measure." While foresters do a good job of estimating the scope of forest fragmentation, they could do even better with comprehensive parcel data as an input to their analysis of parcelization, which is a known driver of fragmentation. Better analytical results from improved data quality and availability are a potential benefit from comprehensive statewide parcel data, which could contribute to greater insights that support well-informed policy-making.

Table: Values of Vermont's Forests[4]

Benefit Category	Benefit Value
Forest Products Economy	The harvest and manufacturing of forest products contributes $1.4 billion in annual economic output to Vermont's economy (NEFA 2013).
Tourism and Recreation	Vermont's largely forest-based tourism economy supports more than 37,000 jobs (about 23% of the employment in the state (Chumura Economics and Analytics 2012); $460 M in annual tourist spending related to fall foliage; $158 M in annual payroll for forest-based recreation jobs.
Flood Protection	Healthy forests have a great capacity to absorb water form heavy rains and moderate its movement.

[4] Op. cit., "2015 Vermont Forest Fragmentation Report."

Benefit Category	Benefit Value
Clean Water	By moderating the flow of water – i.e., by "slowing it down, spreading it out, and allowing it to sink into the soil" – forests not only reduce flood risk, but also increase water quality by reducing or removing sediments, nutrients, and pollutants from entering the water supply.
Clean Air	Forests intercept many air pollutants and store them temporarily on leaves and ultimately on the forest floor and within the soil.
Climate Change Mitigation	Forests also pull carbon from the atmosphere and store it in the soil, trees, and other vegetation in a process known as "carbon sequestration." This offsets a significant portion of heat-trapping carbon dioxide emissions that effect climate change when in the atmosphere.
Wildlife Habitat	Forests provide the components essential to wildlife habitat and survival: food, water, cover, and space. The impact of fragmentation on forest edges, i.e., the "edge effect," is a disturbance to wildlife habitat.
Biological Diversity	Forests are host to many species, as a function of the variety of natural habitats associated with forested conditions. Connectivity and the size of these habitats are important factors in sustaining healthy populations and variety of species.

Benefit Category	Benefit Value
Human Life and Quality of Life	Visiting forests has been linked to human health benefits such as better mood, lower blood pressure, and slower heart rate, and less tension.
Cultural Heritage	As a "working landscape," forests have both economic and intrinsic value for Vermonters, i.e., "the intangible significance of enjoying forests, the natural surroundings, and the quality of life" that is quintessential Vermont.

Fragmentation is not the only stressor of forests that put Vermont's forest-based economy at risk, but it is the dominant one; and it is highly correlated to physical changes and disruption in forests due to parcelization and built infrastructure development, such as[5]:

- New Roads
- New Ditches and ROW maintenance
- New structures and attendant uses
- Conversion of forest to non-forest use

It is clear from the workshops, interviews and research done as part of this project that Vermonters have a strong interest in maintaining the "Vermont way of life" and traditional settlement patterns – i.e., village centers surrounded by fields, farms, and forests. One of the recommendations of the Forest Fragmentation Report is to: *"Consider additional tools for local governments and the state to discourage development that coverts blocks of forest to other uses and requires mitigation when*

[5] Op.cit., "2015 Vermont Forest Fragmentation Report,"p.33.

such development occurs."[6] Accurate, consistent, complete digital parcels for the entire state would contribute measurably to implementing this recommendation, recognizing that it also requires policy-making to change current practices.

8.1.5 CURRENT USE PROGRAM

In 1978 the legislature passed the Use Value Appraisal (Current Use) law. The purpose of the law was to allow the valuation and taxation of farm and forest land based on its remaining in agricultural or forest use instead of its value in the market place. The primary objectives of the program were to keep Vermont's agricultural and forest land in production, help slow the development of these lands, and achieve greater equity in property taxation on undeveloped land. Benefits for land enrolled in the program were first distributed in tax year 1980.

Participation in the program has grown as it has evolved. The two most significant changes have been the inclusion of conservation land owned by qualifying nonprofit organizations and the exemption from all property taxes of eligible farm buildings.

Figure 10. Photo credit: www.maplesweet.com/blog

Currently there are over 18,000 properties enrolled totaling more than 2.4 million acres and representing approximately 1/3 of Vermont's total land area. While a database exists to manage these property records, the mapping of these properties is done on paper. A statewide digital parcel data set would allow the state to map the 18,000 properties and begin to understand the distribution throughout the state. Digital mapping of the current use properties would also allow for better verification (finding duplicates, investigating claims of current use, verifying location and distance to roads). Digital parcels would also reduce the amount of time required by consulting foresters to research property owners and abutters.

[6] Op.cit., "2015 Vermont Forest Fragmentation Report,"p.45.

Furthermore, mapping of current use properties would allow the state to see patterns of land change in ways that are not possible currently.

The cost of the Current Use program in Vermont is $60M per year with $14M going to local cities and towns for tax reimbursement. If the verification process could be improved, even slightly, with statewide digital parcels, this could result in significant cost savings for the state.

8.1.6 QUANTIFIED VALUE OF ECONOMIC DEVELOPMENT BENEFITS

Low Estimate

- Improved New Business Site Selection
    - The low estimate assumes a potential increase in job growth by 1% and a per capita income of $30,566.
    - This results in $5,664,491 of job growth by 2023.
    - Divide this number by 7 to arrive at a "per year" value, and the number is $809,213.
- Preserved Forest Economy
    - Assumes a benefit value (as shown in previous table) for Forest Products Economy of $1.4 billion per year
    - Multiply by .6%, which is the approximate annual growth rate of new households in Vermont (Vermont Housing Finance Agency) to estimate the amount of revenue at risk due to forest fragmentation: $8.4 M per year
    - Multiply this by 1% as the mitigating factor associated with comprehensive statewide parcels for better measurement, prediction, and policy-making for forest fragmentation: $84,000 per year
- Current Use Program Verification
    - Assume a conservative 1% cost savings on the $60M program through improved verification (reduced duplication, verification of location, verification of actual use)
    - This results in $600,000 in potential cost savings to the state

High Estimate

- Improved New Business Site Selection
    - The high estimate assumes a potential increase in job growth by 2% and a per capita income of $30,566.
    - This results in $11,328,982 of job growth by 2023.
    - Divide this number by 7 to arrive at a "per year" value, and the number is $1,618,426.
- Preserved Forest Economy and Tourism
    - Pick a second use case from the set described earlier in this section: Tourism and Recreation
    - Assumes fall foliage tourist-related revenue ($460 M) with annual payroll associated with forest-based recreation jobs ($158 M): $618 M per year
    - Multiply by .6%, which is the approximate annual growth rate of new households in Vermont (Vermont Housing Finance Agency) to estimate the amount of revenue at risk due to forest fragmentation: $3.708 M per year
    - Multiply by 1% as the mitigating factor associated with comprehensive statewide parcels for better measurement, prediction, and policy-making for forest fragmentation: $37,080 per year
    - Combine estimated value associated with Forest Products to Tourism & Recreation: $121,080 per year
- Current Use Program Verification
    - Assume a 2% cost savings on the $60M program through improved verification (reduced duplication, verification of location, verification of actual use)
    - This results in $1,200,000 in potential cost savings to the state

Total Benefit Value to Economic Development from improved New Business Site Selection, Forest Products and Current Use Program verification.

Low Estimate: $1,493,213/year

High Estimate: $2,939,506/year

8.2 PUBLIC SAFETY USE CASES DESCRIBED

In January of 2014 VCGI published a report on "Benefits from Statewide, Consistent, Up-To-Date, Parcel Data," for Public Safety applications. The following use cases were identified in this context:

Table of Public Safety Use Cases[7]

Category	Use Case
Emergency Management	Situational Awareness and Needs Assessment
	Damage Assessment
	Site Selection
	Grant Applications
Fire Safety	Retrieval of Land Ownership Information
	Access Planning
	Forest Fire Response
Law Enforcement	Policing
	E911

[7] See: "Benefits from Statewide, Consistent, Up-To-Date, Parcel Data – Context: Public Safety," VCGI, January 2014.

8.2.1 EMERGENCY MANAGEMENT

- ***Situational Awareness and Needs Assessment:*** Digital parcel data can be used to quickly estimate the number of real properties within a defined area to scope a disaster and response needs to support victims. This can include delineating the area of impact.
- ***Damage Assessment:*** To accurately estimate damage to homes and businesses, the link between parcel maps and appraisal data is valuable for determining the dollar impact of damages, which is an important consideration for Disaster Declarations by the Governor or the President. Hurricane Irene recovery, for example, required rapid and extensive damage assessment, statewide.
- ***Site Selection:*** In emergency response, it is important to be able to identify places for carrying out response operations such as incident command/field offices, debris pile placement, critical supplies and equipment staging and storage, helicopter landing zones, and parking for emergency workers. Locating such things on private property can result in legitimate claims by private land owners for payment from responsible parties for using their property, especially when government-owned alternative land is nearby.
- ***Grant Applications:*** When submitting application for grant funding assistance, parcel data can be an important ingredient in maps that support the application process, e.g., showing the location of a property relative to the damaged areas. This can result in more assistance money coming to the State for mitigating damages (e.g., post-Hurricane Irene assistance).

8.2.2 FIRE SAFETY

- ***Retrieval of Land Ownership Information:*** Parcel data can support the identification of property owners for fire-fighting and HAZMAT operations, such as crystal methamphetamine (i.e., crystal meth) labs.
- ***Access Planning:*** Parcel data can be critical to the timely identification of property access options for first responders at the scene of a fire or other disaster. Ingress-egress easements are not always obvious in the field, for example, but can be located on a parcel map.
- ***Forest Fire Response:*** For some forest fires, the burn might be deep within a forest. To respond, parcel data helps identify what property may need to be crossed, and what landowners might be impacted.

8.2.3 LAW ENFORCEMENT

- ***Policing:*** When responding to a complaint or suspicious activity, parcel data can help policemen locate and identify the owner of the property in question, to determine on whose property the activities are actually occurring. Parcel data can also be combined with other data in an investigation, such as utility billing data linked to property owner names, or crime records.
- ***E911:*** Parcel data benefits E911 programs by providing additional context to help first responders, such as showing different access points to the property. Also, address points (rather than ranges) can be derived from parcel data. It can help resolve multi-jurisdictional coordination issues and mutual aid agreements, too (e.g., showing parcels in one jurisdiction that can only be accessed from another).

8.2.4 QUANTIFYING THE BENEFITS FOR PUBLIC SAFETY

The two use cases from the aforementioned set that will be used to quantify benefits associated with accurate, consistent, complete parcel data for the entire state are:

1) Emergency Response: Damage Assessment
2) Fire Safety: Access Planning

Hurricane Irene hit Vermont in August of 2011, causing damage in 225 of the state's 251 towns and villages, to both private property and public infrastructure. Due to severe flooding and extensive damage to roads and bridges, VTrans took a leading role in the recovery, in collaboration with the state's 11 Regional Planning Commissions (RPCs). In fact, Sue Minter of VTrans was appointed by Governor Shumlin to be the state's Irene Recovery Officer. Estimated damage to the state's transportation network alone was hundreds of millions of dollars, based on estimated cost to repair or replace damaged infrastructure.

Governor Shumlin declared a **state of emergency** during the storm, and President Obama signed a Presidential Disaster Declaration (PDD) for Vermont in the aftermath, making the federal Stafford Act and the Federal-Aid Highway Act applicable for disaster relief and emergency assistance. The extent of damages included:

- Over 7000 homeowners registered damages with FEMA; over 5000 received assistance
- 629 historical and cultural sites
- 20,000 acres of farmland
- 220 businesses
- Over 500 miles of state highways and 34 bridges
- Over 2000 town road segments, 963 culverts, and 227 bridges
- 14 covered bridges
- 5 state-owned railroad bridges
- Water supplies and sewage treatment facilities were compromised
- Hazardous spills occurred, putting public health at-risk

Sources: *"*Lessons Learned from Irene: Vermont RPCs Address Transportation System Recovery," NADO Foundation, July 2012; Clancy and Grannis, "Lessons Learned from Irene: Climate Change, Federal Disaster Relief, and Barriers to Adaptive Reconstruction," Georgetown Law, December 2013; https://www.fema.gov/disaster/4022; and, http://governor.vermont.gov/blog-gov-shumlin-irene-anniversary

Emergency Response: Damage Assessment

The costs and challenges faced by state agencies, towns, villages, and property owners to recover from a natural disaster of the magnitude of Hurricane Irene are great – and it could happen again in Vermont. Being able to quickly assess the extent of the damage, including the location and names of impacted property owners, is essential in planning the recovery effort and the distribution of assistance. Reimbursement is not always a straightforward process, and there can be legal barriers and demands for better information to document damages and provide proof of those who are impacted. This requires better parcel data for the entire state to help ensure that both municipalities and residents get the assistance they need to recover from future events that are like Irene in severity.

Figure 11. Hurricane damage in Waterbury, VT. Photo credit: www.naplesnews.com/news/latest-photos-damage-caused-irene

The damage costs from Tropical Storm Irene were over $850 million according to the Irene Recovery Report, including[8]:

- Federal: $602.72 million
- State: $144.81 million
- Local: $8.70 million
- Private: $31.31 million
- Insurance: $63 million

As remarkable as the recovery effort has been, action on damage repairs and rapid receipt of recovery funding could have been facilitated by better digital parcel data linked to property

[8] http://vem.vermont.gov/vtstrong/

ownership information. Just looking at the financial assistance from FEMA as post-Irene damage relief, the following numbers were published in a number of sources:

Financial Assistance from FEMA	Amount (rounded)
Individual Assistance	$23 million
Public Assistance	$143 million
Total	**$166 million**

Accurate, consistent, complete parcel data not only help to assess damages and the property owners who are impacted, but can also help by informing decisions on floodplain management, both long before and during the events. This can be a net social benefit in a few ways:

- Making sure that the people who need the assistance get it – i.e., clear evidence of the property intersecting with the delineated damage area can expedite claims.
- Eliminating errors and even fraud in applications for assistance, or reimbursement – i.e., is the property in question actually within an area that suffered damages?
- Proactively reducing the risk of future damages to property with better data to inform floodplain management -- if the contemplated development or existing property is in a flood prone area and at risk, what proactive damage prevention measures can be taken?

Going forward, better data will help protect people and their future investments in property and land development by reducing the risk of potential damages due to decisions made with less than ideal data – both developers and regulators would more probably than not agree on this point. Being able to more accurately predict the areas that will be inundated at different flood stages, in advance of big rain events in the future, will save lives, property, and money spent on damages. Better data is a risk mitigation strategy.

Given the large amount of money involved in recovering from a natural disaster such as Irene, there is a rational argument to be made that anything Vermont can do to better predict the risk of flooding can result in reductions in damage costs, and faster recovery. The FEMA assistance to Vermont of just over $166 million is only about 20% of the $850 million of estimated damages to homes, businesses and infrastructure. These numbers are from the Irene Recovery Report (op. cit.), and they give a sense of magnitude to what can actually happen. This is not to say that anything should have been done differently to mitigate damages in 2011. Rather, it is to point out the importance of having better parcel data in the future to support Vermont's growth, and to reduce the risk of future damages.

List of Storm Events in Vermont registered by FEMA from 2010-2015 as major disasters[9]:

FEMA#	Date	State	Type of Disaster	Declaration
4207	2/3/2015	Vermont	Severe Winter Storm	Major Disaster Declaration
4178	6/11/2014	Vermont	Severe Storms and Flooding	Major Disaster Declaration
4163	1/29/2014	Vermont	Severe Winter Storms	Major Disaster Declaration
4140	8/2/2013	Vermont	Severe Storms and Flooding	Major Disaster Declaration
4120	6/13/2013	Vermont	Severe Storms and Flooding	Major Disaster Declaration
4066	6/22/2012	Vermont	Severe Storm, Tornado, & Flooding	Major Disaster Declaration
4043	11/8/2011	Vermont	Severe Storms And Flooding	Major Disaster Declaration
4022	9/1/2011	Vermont	Tropical Storm Irene	Major Disaster Declaration
3338	8/29/2011	Vermont	Hurricane Irene	Emergency Declaration
4001	7/8/2011	Vermont	Severe Storms And Flooding	Major Disaster Declaration
1995	6/15/2011	Vermont	Severe Storms and Flooding	Major Disaster Declaration
1951	12/22/2010	Vermont	Severe Storm	Major Disaster Declaration

Fire Safety: Access Planning

As described in the aforementioned VCGI report on Public Safety, parcel data can be critical to the timely identification of property access options for first responders at the scene of a fire or other

[9] http://www.fema.gov/disasters/grid/state-tribal-government/35?field_disaster_type_term_tid_1=All

disaster. Ingress-egress easements are not always obvious in the field, for example, but can be located on a parcel map.[10]

An important part of fire safety is pre-incident planning, which can help to save lives and property through better information in advance of an event. A Pre-Incident Plan (PIP) is a *"document developed by gathering general and detailed data used by responding personnel to determine the resources and actions necessary to mitigate anticipated emergencies at a specific facility."*[11] In the context of pre-incident planning for fire suppression and rescue services, parcel data can be a useful if not invaluable resource, to help evaluate and analyze the plot plan for site considerations for a given property, and to provide information about the occupants and type of dwelling. It can contribute to a better understanding in advance of areas that are accessible or inaccessible for fire and rescue equipment. Collecting and organizing such data is an important but time-consuming task, and easy access to parcel data would help fire safety personnel in developing a PIP.

8.2.5 QUANTIFIED VALUE OF PUBLIC SAFETY BENEFITS

Low Estimate

- Pick one use case from the set described earlier in this section: Damage Assessment for Emergency Management
- Take the amount of financial assistance received from FEMA (shown previously): $166 M
- Divide it by 10 as a way of mathematically annualizing this value (based on economic plausibility, not meteorology – i.e., as shown in the table above, there have been 12 storm events since 2010 that qualified for FEMA financial assistance): $16.6 M

Figure 12. Photo credit: http://archive.burlingtonfreepress.com/

[10] Op. cit., See: "Benefits from Statewide, Consistent, Up-To-Date, Parcel Data – Context: Public Safety," VCGI, January 2014.

[11] See: "NFPA 1620: Standard for Pre-Incident Planning," National Fire Protection Association, 2015.

- Multiply the annualized value by 1% as the amount of expected annual benefits (potentially, from either reduced assistance needed, or greater success in getting needed assistance – either one would be a net social benefit) from the availability and utilization of digital parcel data in risk management, damage assessment, and emergency response: $166,000/year

<u>High Estimate</u>

- Pick a second use case from the set described earlier in this section: Access Planning for Fire Safety
    - In 2012 fire departments in Vermont responded to 47,653 emergency incidents (almost 4000 per month)[12]
    - These included 15,749 EMS calls (approx. one-third of all incidents) that were non-vehicular incidents[13]
    - For the 4-year period 2008-11, there were over $242 million in reported dollar losses by insurance companies related to fires in Vermont (on average $60 M/year in fire-related property losses)[14]
    - Over the 5-year period from 2008-2012, there were 30 deaths from fires in Vermont[15]
- Make the assumption that accurate, consistent, complete digital parcel data will improve access planning for fire safety, resulting in 1 less fatality over a 5-year period: $5.2 M[16]
    - This is based on the economic notion of the "value of a statistical life" (VSL)
    - For analyses in 2014, USDOT used a VSL of $9.2 M (based on a range of alternative values from $5.2 M to $13.0 M)
- Spread the $5.2 M VSL over 5 years: $1.04 M per year
- Divide by 2 to be extra conservative: $520,000 per year

Not knowing the true value of a life, economists developed the concept of the "value of a statistical life" (VSL) as a substitute. As defined by USDOT, "VSL is the benefit of preventing a fatality, defined as the additional cost that individuals would be willing to bear for improvements in safety that reduce the expected number of fatalities by one." This is not the valuation of life as such, but the valuation of a reduction in risks.

[12] "2012 Annual Report of the State Fire Marshall," Vermont Department of Public Safety, Division of Fire Safety.
[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] "Guidance on Treatment of the Economic Value of a Statistical Life (VSL)," USDOT, June 2014.

- Combine with the $166,000 per year for benefit to Damage Assessment: $686,000 per year

Public Safety Benefit Value from Statewide Digital Parcel Data

Low Estimate: $166,000/year

High Estimate: $686,000/year

8.3 STORMWATER MANAGEMENT USE CASES DESCRIBED

Regulatory requirements to map stormwater systems, as part of stormwater management programs such as the Phase II of NPDES (National Pollutant Discharge Elimination System) stormwater program applies to MS4 (Municipally Separated Storm Sewer System), include mapping above and below ground infrastructure with a goal of identifying all stormwater flows and discharges. Stormwater management also requires the ability to map and model land cover and land use characteristics as they affect stormwater runoff.

In addition to MS4 owners and operators, there are a large number of entities in the state which discharge non-ground water flows to the State's waters. These discharges include stormwater runoff, which can affect water quality of surface and groundwater supplies due to pollutants and erosion caused by excessive volumes and rates of stormwater runoff.

Statewide digital parcels would be instrumental in supporting the complex management of stormwater activities and infrastructure in the state. The table below highlights some of the key uses cases and the sections below describe the benefits in more detail.

Category	Use Case
Project Planning/Management	Avoided research to identify ownership and abutters
	Streamlined permitting
	Vegetation management
Site Selection	Assess interest and value to Stormwater Management
	Identify sites for milkweed, butterflies
	Avoid loss of compensation for encroachment

Encroachment Detection/Prevention	Preventative education

8.3.1 STREAMLINED STORMWATER PERMITTING

Digital parcels provide an efficient and effective stormwater management tool when applied to stormwater management in the state for the ongoing protection of water resources from runoff pollution, erosion, and ineffective land use policies. Due to the fact that stormwater management requires the ability to see what is happening across a watershed as well as what is occurring at specific sites within the watershed, parcels give context to land use activities which can help or hinder water quality issues.

Statewide digital parcels would also assist in responding to citizen inquiries as well as resolving disputes and appeals of current stormwater assessments. In addition, statewide parcels would help stormwater management staff easily identify property owners and abutters. Currently, they must spend a significant amount of time researching this information, and as state projects often cross multiple town boundaries, this often requires on-site research at multiple town halls.

In general these efficiencies, would lead to a streamlined permitting process and reduced staff time spend managing and tracking each permit.

8.3.2 ENFORCEMENT OF RIGHTS

Statewide parcels would allow transportation land managers to visually assess their lands in relation to the overall context of land ownership and quickly identify abutters that are likely responsible for encroachment and/or buffer violations. Routine, comprehensive field assessment is often not feasible as the exterior boundaries of lands controlled by the state's transportation agency are extensive. Statewide parcel boundaries would provide agency staff or their agents with immediately accessible information regarding the owners of land subject to notification, investigation or enforcement actions. Parcel mapping, which eliminates the interpolation error of commercial geocoding, would directly support such requirements and allow staff to implement operational and regulatory mandates more efficiently and effectively. This could result in cost savings by preventing encroachment and damage to state property and stormwater infrastructure and also time savings for staff that must currently research, respond and repair such damage.

8.3.3 COLLECTION OF FEES

Statewide parcels would support the assessment and collection of applicable stormwater fees throughout the state. Stormwater fees are based on the percentage of impervious area relative to an entire parcel's size. All parcels (including vacant/undeveloped) are charged a fee on the basis of their intensity of development, which is defined as the percentage of impervious area of the parcel. Statewide digital parcels would allow stormwater managers to identify owners of land and, in conjunction with orthoimagery, identify the intensity of development and relative impervious area of any given parcel.

8.3.4 QUANTIFIED VALUE OF STORMWATER MANAGEMENT BENEFITS

Low Estimate

- Assumes 8 hours per week (416 hours per year) state staff time is saved researching property owners and abutters to support stormwater management and permitting
- Assumes 8 hours per week (416 hours per year) state staff time is saved addressing property and infrastructure damage from encroachment
- Assumes avoided property and infrastructure costs of $100,000 per year
- Assumes 2 hours saved managing each permit (estimated 936 permits /year) for a total of 1,871 hours per year
- Assumes a conservative fully loaded staff rate of $50,000 for valuing labor costs
- Results in an annual cost savings of $235,000

High Estimate

- Assumes 24 hours per week (1,248 hours per year) state staff time is saved researching property owners and abutters to support stormwater management and permitting
- Assumes 24 hours per week (1,248 hours per year) state staff time is saved addressing property and infrastructure damage from encroachment
- Assumes avoided property and infrastructure costs of $200,000 per year
- Assumes 2 hours saved managing each permit (estimated 1,404 permits /year) for a total of 2,808 hours per year
- Assumes a conservative fully loaded staff rate of $50,000 for valuing labor costs

- Results in an annual cost savings of $465,200

Stormwater Management Benefit Value from Statewide Digital Parcel Data

Low Estimate: $235,200/year

High Estimate: $465,200/year

9 QUANTITATIVE FINDINGS

9.1.1 SUMMARY OF BENEFITS

The quantification of benefits focused on Economic Development, Public Safety, and Stormwater Management. These three particular applications of digital parcel data were used in this study to enumerate the benefits of accurate, current, consistent, and complete digital parcel data for the entire state. These particular benefits, rather than the entire universe of potential benefits, were quantified based on making certain assumptions, which are documented in this study. It is fair to say that if the entire universe of benefits was enumerated, the total value of benefits would be notably larger than the conservative numbers seen below. In addition, this study applied a low and a high estimate to benefits, to provide a range of likely ROI. For the 5-year contemplated program, the expected benefits are from $6 million on the low side, to $12.9 million on the high side.

		Discount Rate = r =	**0.4%**		**NPV=**	$\text{Benefit}_t/(1+r)^t$
		(1+r)=	**1.0040**		**t=**	{0,1,2,3,4}
t=	0	1	2	3	4	
USE CASES "LOW" BENEFIT VALUES	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**TOTALS**
Stormwater	$ 235,200	$ 235,200	$ 235,200	$ 235,200	$ 235,200	**$1,176,000**
Economic Develoment	$ 809,213	$ 809,213	$ 809,213	$ 809,213	$ 809,213	**$4,046,065**
Public Safety	$ 166,000	$ 166,000	$ 166,000	$ 166,000	$ 166,000	**$830,000**
TOTALS:	***$1,210,413***	***$1,210,413***	***$1,210,413***	***$1,210,413***	***$1,210,413***	***$6,052,065***
NPV:	**$1,210,413**	**$1,205,591**	**$1,200,787**	**$1,196,003**	**$1,191,239**	**$6,004,033**
USES CASES "HIGH" BENEFIT VALUES						
Stormwater	$ 465,200	$ 465,200	$ 465,200	$ 465,200	$ 465,200	**$2,326,000**
Economic Develoment	$ 1,618,426	$ 1,618,426	$1,618,426	$1,618,426	$1,618,426	**$8,092,130**
Public Safety	$ 520,000	$ 520,000	$ 520,000	$ 520,000	$ 520,000	**$2,600,000**
TOTALS:	***$2,603,626***	***$2,603,626***	***$2,603,626***	***$2,603,626***	***$2,603,626***	***$13,018,130***
NPV:	**$2,603,626**	**$2,593,253**	**$2,582,921**	**$2,572,631**	**$2,562,381**	**$12,914,812**

9.1.2 RETURN ON INVESTMENT CALCULATIONS

To complete the ROI calculations, the benefits quantified in the section above were compared to the costs of transforming existing digital parcel data to a state standard, creating new digital parcel data where needed, and then maintaining this data over a five year period. In dollar terms, the estimated costs for the 5-year recommended program are $2.3 million, and the expected benefits for the same period of time are from $6 million on the low side, to $12.9 million on the high side. The estimated costs for the 5-year alternative program are $2.1 million[17], and the expected benefits remain the same. Based on these low and high numbers, the resulting ROI ratio ranges from a very conservative 1.58 to 4.55 for the recommended implementation approach and a range of 1.8 to 5.03 for the alternative implementation approach.

Cost-Benefit Analysis - "Low"	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Benefits Summary - "Low"	$1,210,413	$1,210,413	$1,210,413	$1,210,413	$1,210,413	$6,052,065
Cost Summary	$583,686	$633,196	$695,099	$214,269	$214,269	$2,340,519
Discounted Benefits - "Low"	$1,210,413	$1,205,591	$1,200,787	$1,196,003	$1,191,239	$6,004,033
Discounted Costs	$583,686	$630,673	$689,571	$211,718	$210,875	$2,326,524
Net Present Value	**$626,727**	**$574,917**	**$511,216**	**$984,285**	**$980,364**	**$3,677,510**
Return on Investment (ROI) "Low"	**1.58**					
Cost-Benefit Analysis - "High"	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**TOTAL**
Benefits Summary - "High"	$2,603,626	$2,603,626	$2,603,626	$2,603,626	$2,603,626	$13,018,130
Cost Summary	$583,686	$633,196	$695,099	$214,269	$214,269	$2,340,519
Discounted Benefits - "High"	$2,603,626	$2,593,253	$2,582,921	$2,572,631	$2,562,381	$12,914,812
Discounted Costs	$583,686	$630,673	$689,571	$211,718	$210,875	$2,326,524
Net Present Value	**$2,019,940**	**$1,962,580**	**$1,893,350**	**$2,360,913**	**$2,351,507**	**$10,588,289**
Return on Investment (ROI) "High"	**4.55**					

Figure 13. Cost Benefit Analysis Using Recommended Implementation Approach

[17] It should be noted that the potential loss of existing jobs in not included as a cost for the alternative implementation approach nor is any cost assessed to the perception of a parcel maintenance "takeover" by the state.

Vermont ROI for Statewide Parcels

Cost-Benefit Analysis Using Alternative Implementation Approach

Discount Rate = r =	**0.4%**					
Cost-Benefit Analysis - "Low"	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**TOTAL**
Benefits Summary - "Low"	$1,210,413	$1,210,413	$1,210,413	$1,210,413	$1,210,413	$6,052,065
Cost Summary	$583,686	$610,170	$651,116	$154,442	$154,442	$2,153,856
Discounted Benefits - "Low"	$1,210,413	$1,205,591	$1,200,787	$1,196,003	$1,191,239	$6,004,033
Discounted Costs	$583,686	$607,739	$645,938	$152,603	$151,995	$2,141,962
Net Present Value	**$626,727**	**$597,852**	**$554,849**	**$1,043,400**	**$1,039,243**	**$3,862,071**
Return on Investment (ROI) "Low"	**1.80**					
Cost-Benefit Analysis - "High"	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**TOTAL**
Benefits Summary - "High"	$2,603,626	$2,603,626	$2,603,626	$2,603,626	$2,603,626	$13,018,130
Cost Summary	$583,686	$610,170	$651,116	$154,442	$154,442	$2,153,856
Discounted Benefits - "High"	$2,603,626	$2,593,253	$2,582,921	$2,572,631	$2,562,381	$12,914,812
Discounted Costs	$583,686	$607,739	$645,938	$152,603	$151,995	$2,141,962
Net Present Value	**$2,019,940**	**$1,985,514**	**$1,936,983**	**$2,420,027**	**$2,410,386**	**$10,772,850**
Return on Investment (ROI) "High"	**5.03**					

Figure 14. Cost Benefit Analysis Using Alternative Implementation Approach

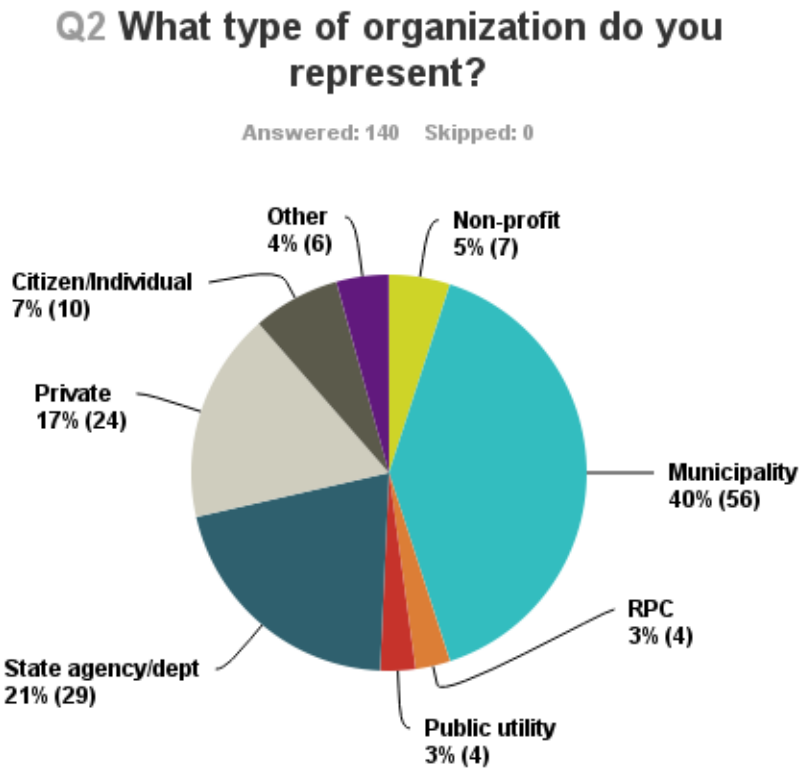
APPENDICES

APPENDIX A. SURVEY RESULTS

A survey was conducted during December of 2014 to gather input for the Statewide Parcel ROI Study, in advance of the interviews and workshops that will be conducted in three locations during February 2015. The following is a summary list of the questions that were asked, followed by pie charts or bar charts showing the distribution of responses for the 140 participants in the survey.

- What type of organization do you represent?
- Do you use digital parcel data to perform your job?
- How often do you use digital parcel data?
- Approximately how much time do you save?
- What were you methods before digital parcel data was available?
- Do you have to obtain parcel data from multiple sources?
- Are you able to obtain digital parcel data for all your areas of interest?
- What are the top benefits of statewide digital parcels?
- Relative to other basemap layers, how important are digital parcels?
- Should the State create a program to support the creation of parcels for each Town?
- How should parcel data be maintained in the future?

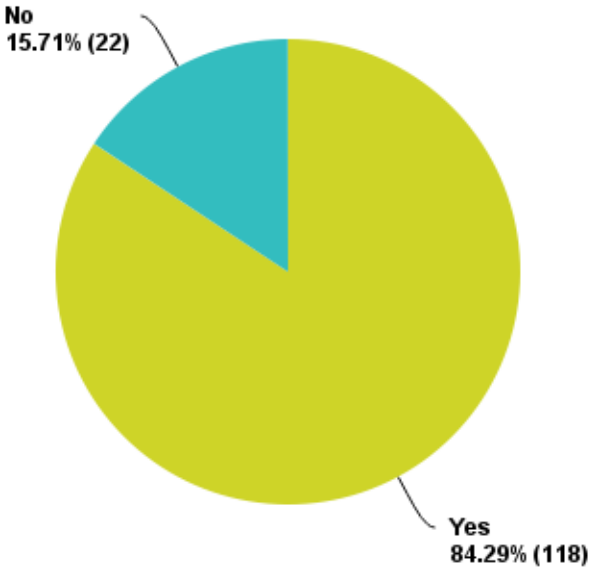
9.2 WHAT TYPE OF ORGANIZATION DO YOU REPRESENT?



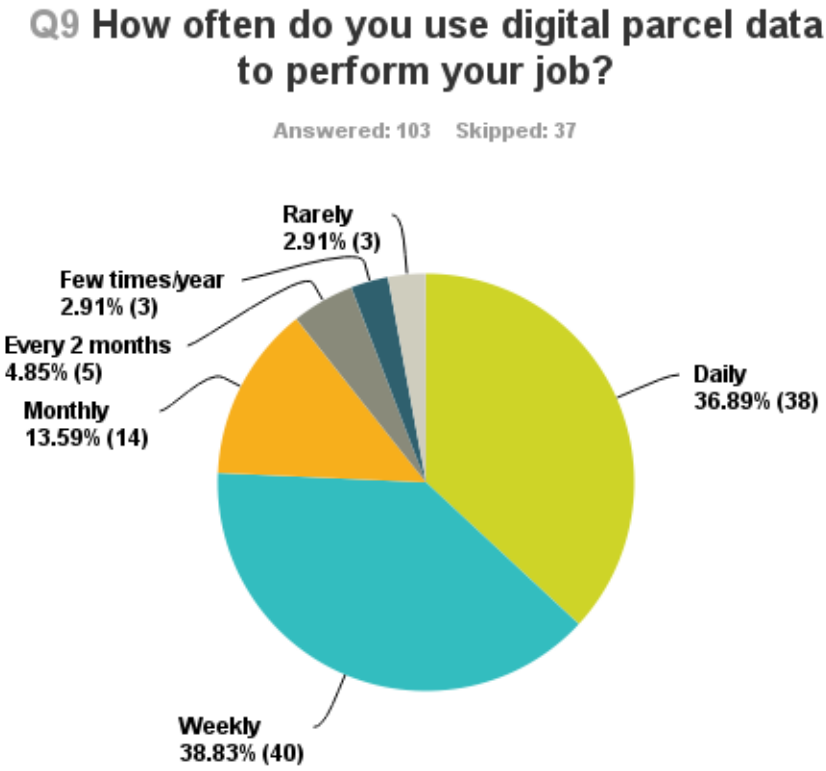
9.3 DO YOU USE DIGITAL PARCEL DATA TO PERFORM YOUR JOB?

Q7 Do you currently use digital parcel data to perform your job?

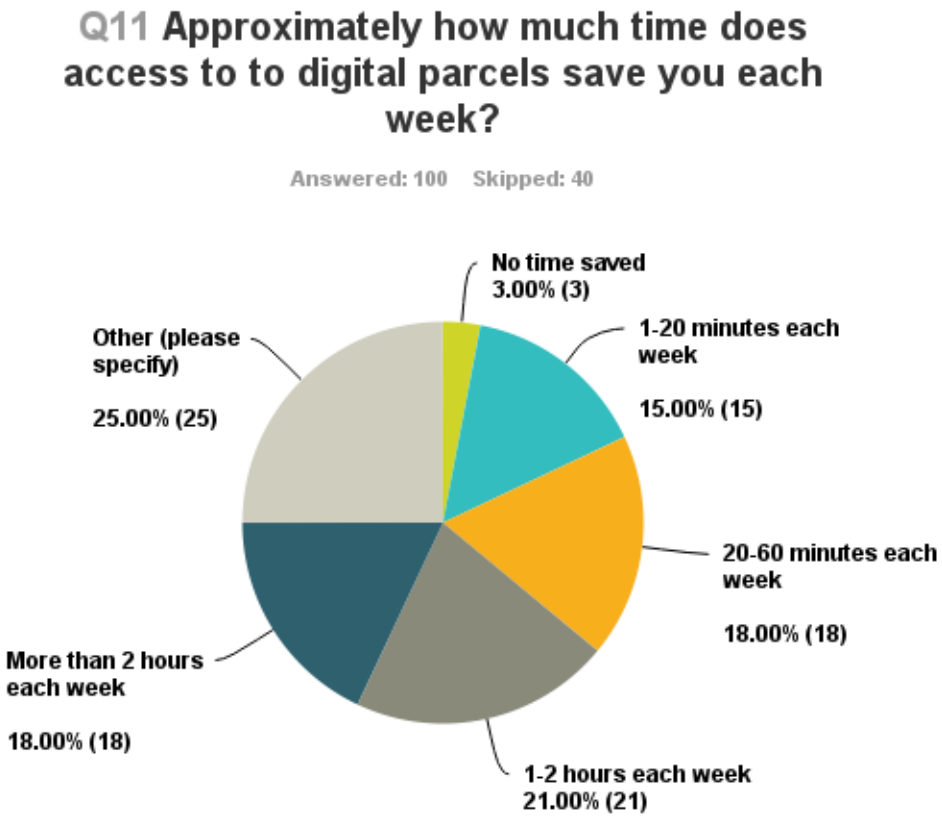
Answered: 140 Skipped: 0



9.4 HOW OFTEN DO YOU USE DIGITAL PARCEL DATA?



9.5 APPROXIMATELY HOW MUCH TIME DO YOU SAVE?

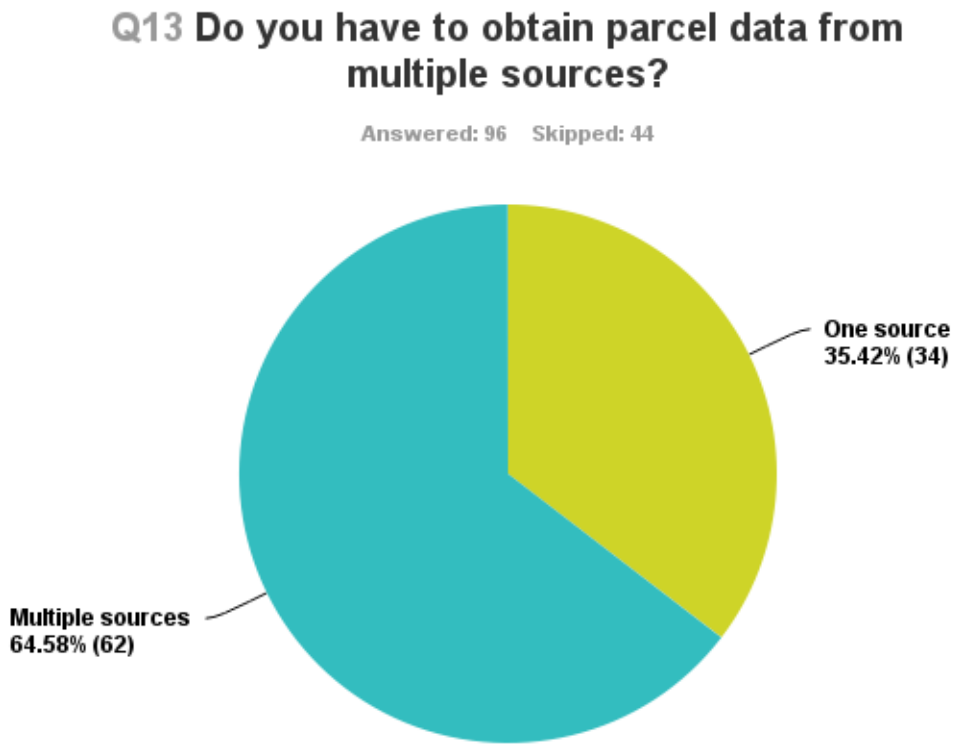


9.6 WHAT WERE YOUR METHODS BEFORE DIGITAL PARCEL DATA WAS AVAILABLE?

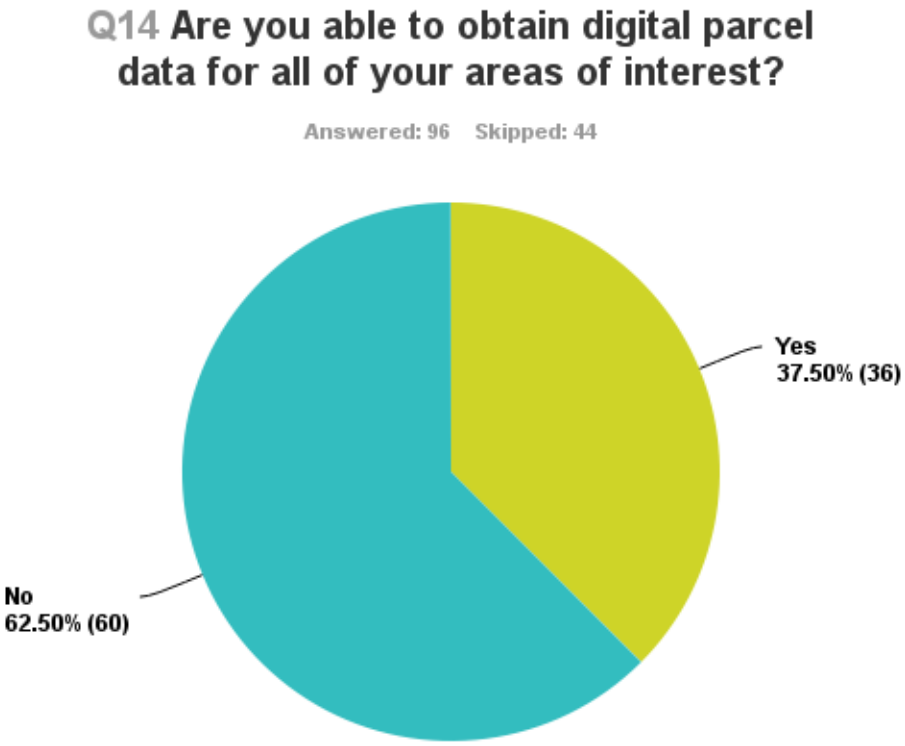
- Call or visit the Town Clerk to obtain property information
- Reference imagery, surveys, “as-built” drawings, record plans, or old Beers maps
- Obtain hard copies of tax maps from towns
- Conduct deed research
- Go to all nearby residences until owner is found
- Conduct very time consuming process of extracting data off old plans or other sources
- Sometimes, do not do the work at all

- Went “without”

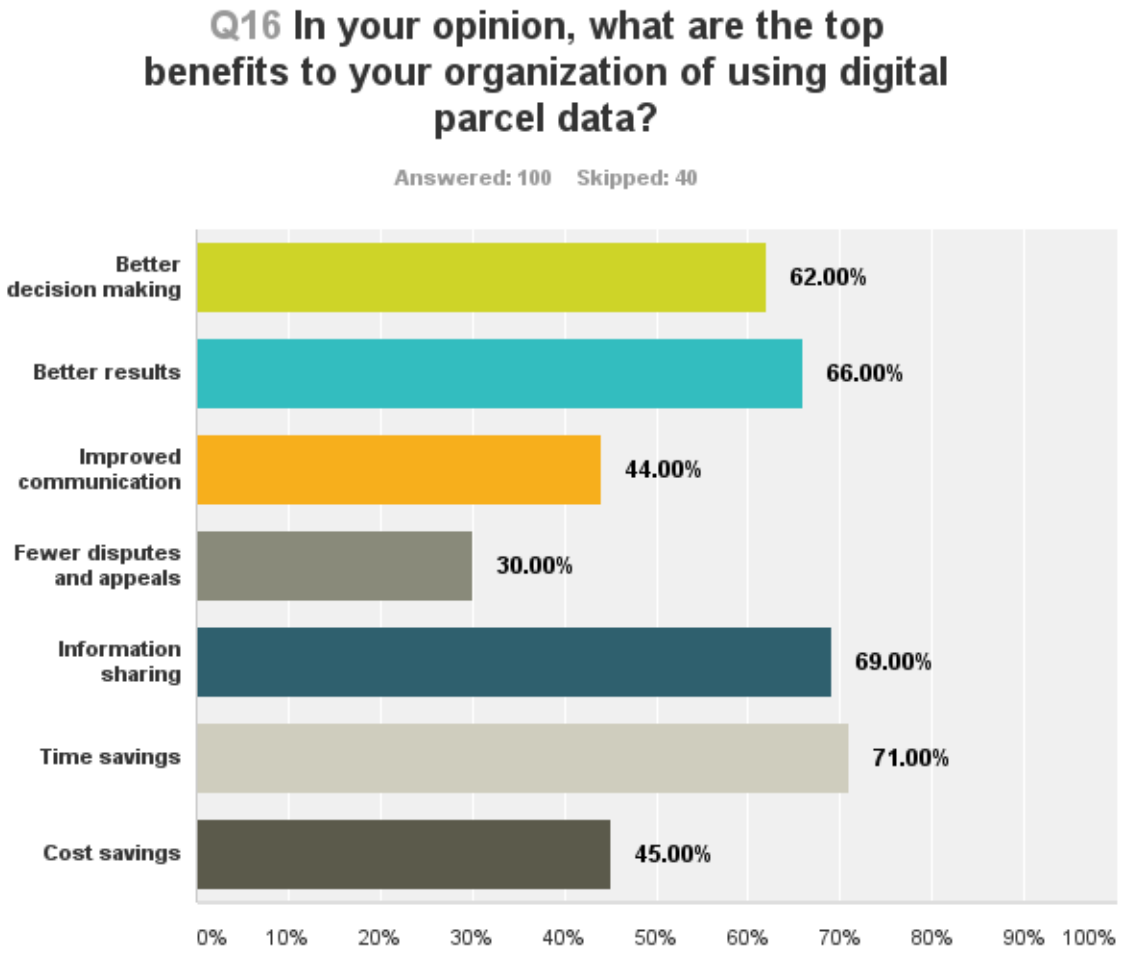
9.7 DO YOU HAVE TO OBTAIN DIGITAL PARCEL DATA FROM MULTIPLE SOURCES?



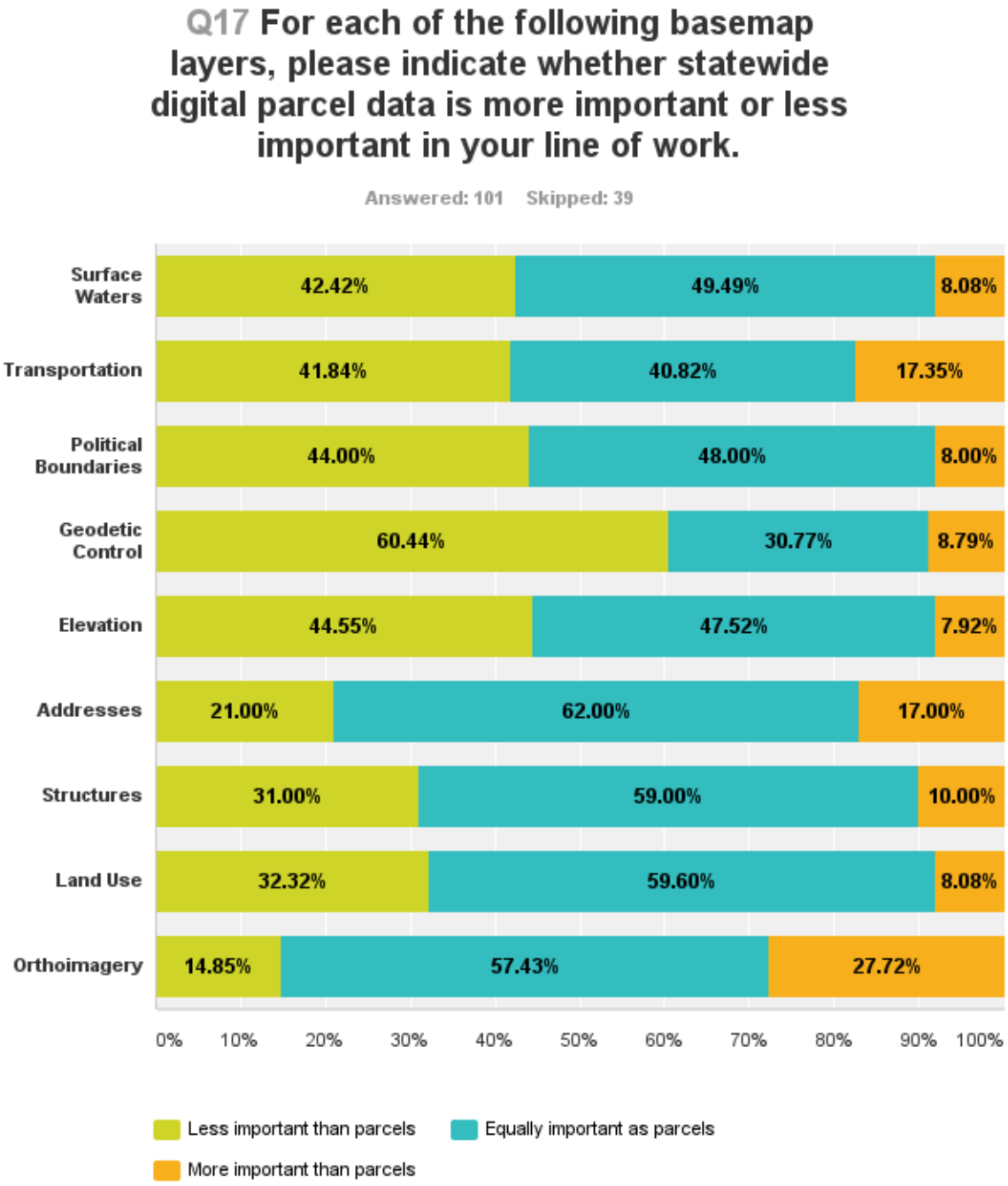
9.8 ARE YOU ABLE TO OBTAIN DIGITAL PARCEL DATA FOR ALL YOUR AREAS OF INTEREST?



9.9 WHAT ARE THE TOP BENEFITS OF STATEWIDE DIGITAL PARCELS?



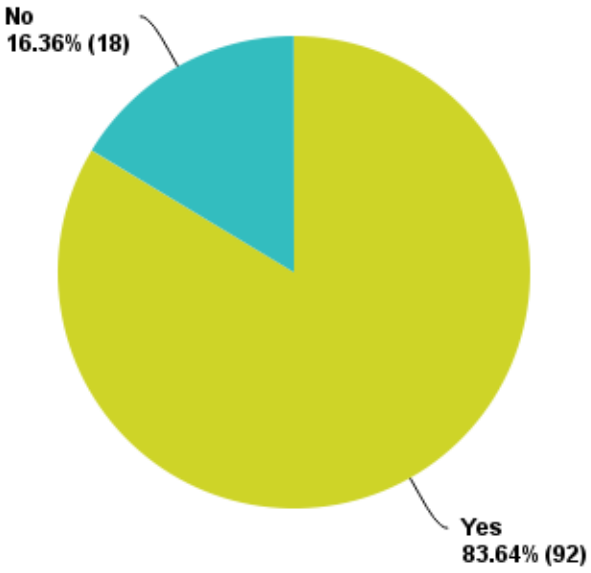
9.10 HOW IMPORTANT ARE DIGITAL PARCELS AS COMPARED TO OTHER BASEMAP DATA LAYERS?



9.11 IN YOUR OPINION, SHOULD THE STATE CREATE A PROGRAM TO CREATE DIGITAL PARCELS FOR EACH TOWN?

Q22 Do you think the state should create a program to support the creation of consistent, current, parcel data for each town?

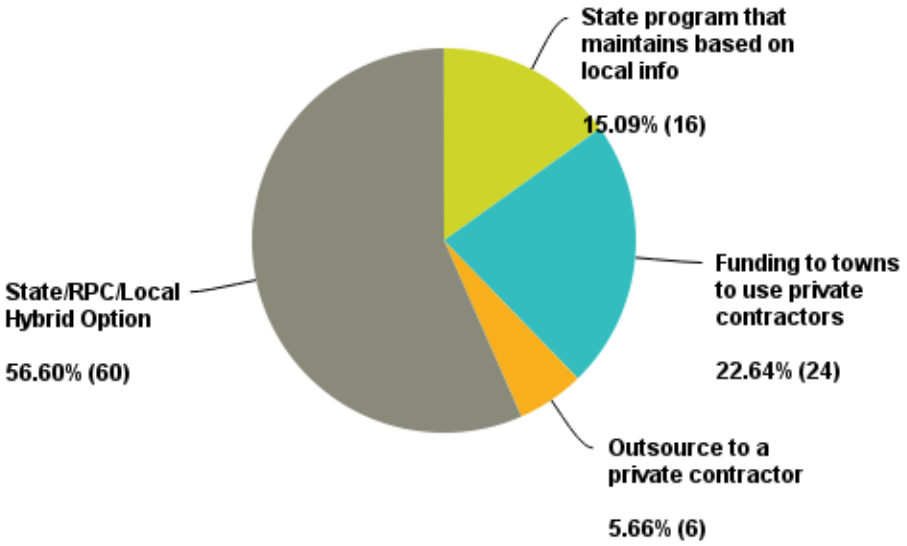
Answered: 110 Skipped: 30



9.12 WHAT SHOULD THE FUTURE MAINTENANCE OF DIGITAL PARCELS LOOK LIKE?

Q23 Which of the following programs would you prefer for future maintenance of statewide parcel data?

Answered: 106 Skipped: 34

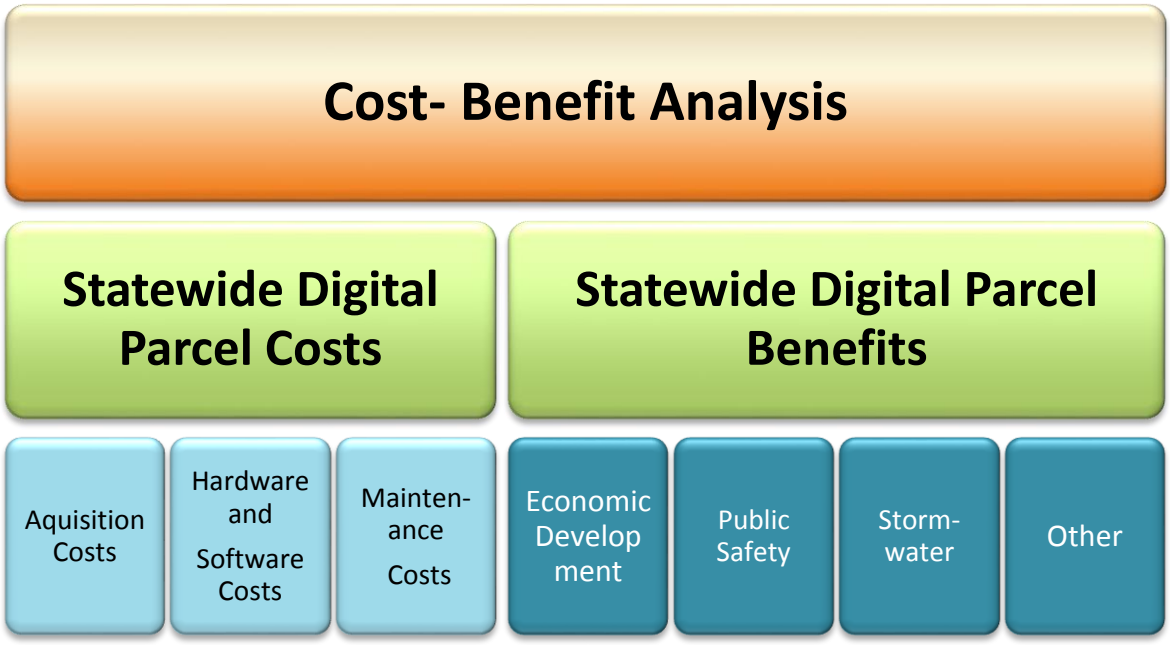


APPENDIX B. COST-BENEFIT ANALYSIS METHODOLOGY

This section describes the Cost-Benefit Analysis (CBA) Methodology used to estimate return on investment (ROI) for statewide digital parcels for the state of Vermont. An Excel workbook was developed for each selected case study (i.e. Economic Development, Stormwater, and Public Safety). Each workbook contains several worksheets (tabs) that were used to estimate the benefits of statewide digital parcels for the particular case study, and then perform a cost-benefit analysis, using cost estimates supplied by the state of Vermont.

9.13 CONCEPTUAL DIAGRAM

The diagram below provides an overall conceptual view of CBA for statewide digital parcels in Vermont. The items in teal on the bottom right of the diagram are example use cases for estimating benefits. A very conservative approach was taken to quantifying benefits, by limiting the enumeration to a small subset of the universe of potential benefits. Since benefits also accrue to applications that were not included in the quantification effort, it can be assumed that the full value of benefit is greater than just the value of the subset of use cases that were enumerated. In addition, care was taken not to double-count any benefits. The costs were estimated with input from the state.



9.14 OVERVIEW

The methods described in this document for developing Return on Investment (ROI) metrics are based on CBA. CBA techniques yield both a net present value (NPV) dollar amount, and the terms for the ROI equation (benefits minus costs, divided by costs), to derive the ROI ratio for the project being analyzed. The level of effort associated with developing a comprehensive CBA, to include all benefits and opportunity costs, is a significant undertaking beyond the scope of this project; but even an effort bounded to a subset of the benefits yielded results favorable to a financial business case.

9.15 COMPONENTS OF COST-BENEFIT ANALYSIS

If stakeholders are to support investment at the enterprise level, they need to be convinced it is worthwhile, and that the justification is clear. The basic components to CBA are listed below and explained in subsequent paragraphs:

- Costs

- Benefits
- Time Period
- Discount Rate (including inflation and cost of capital)
- Net Present Value
- Sensitivity Analysis
- Return on Investment (ROI) Calculation
- Opportunity Cost Analysis

9.15.1 COSTS

Calculating costs is fairly straightforward as compared to benefits. Briefly, costs amount to the money that you must spend to establish the program, including data development, hardware, software, and personnel. Their dollar value is a function of documented market prices and known compensation and expenses. The following items are representative of the basic costs:

- Staff costs (initial and recurring)
- Consulting support (if required)
- Initial data development costs
- Ongoing data maintenance costs
- Ongoing operational costs for personnel
- Ongoing program management costs
- Processing and storage costs

The costs of developing statewide digital parcels are based on an estimate by the state, with the duration of acquisition spread over 5 years at different frequencies of update, depending on the location and other factors.

9.15.2 BENEFITS

While the dollar value of costs is a function of documented market prices and known compensation and expenses, the same cannot as easily be said of benefits. The main focus of this study was on

enumerating defensible benefits, by asking subject matter experts to answer specific questions based on their experience, professional opinion, and prevailing views in the industry.

There is no directly observable market valuation that places a dollar amount on the benefits presented in this ROI. When there is no obvious value as a function of market prices, there are methods to make an estimate based on "shadow" prices. These methods include looking at observable markets for analogous things that can be measured (market analogies), or asking people for their opinions on what something is worth using various survey methods and research (contingent valuation), such as interviews and business logic. [18] For this study, the contingent valuation method was primarily used. Some level of bias is unavoidable from either the researcher or the informant, or both; and it is hereby acknowledged as part of the process. Therefore, the benefits findings were intentionally kept conservative to balance any optimistic bias.

Procedures for identifying and reaching out to respondents included in-person and telephone interviews, and e-mail correspondence. To make the questions as realistic as possible, and to narrow-down the target population for garnering responses, case studies were developed for important statewide applications.

Once benefits were identified through interviews and research, they were entered into a spreadsheet. Depending on the professional opinion of the interviewer on the certainty of the information being collected, a probability factor could be applied to reduce the value of the calculated benefits accordingly. However, the calculated benefits were judged to be very conservative without factoring them down, and therefore, the probability factor for the estimated outcomes was assumed to be 100%.

[18] Boardman, Greenberg, Vining, and Weimer. Cost-Benefit Analysis Concepts and Practices: 4th Edition. Prentice Hall, Boston, 2011.

9.15.3 TIME PERIOD

To compare investment alternatives in terms of net present value (NPV) it is necessary to discount the future stream of benefits and costs for a certain time period. **The time period selected for the Vermont Parcel ROI project is 5 years**, even though the potential project life could be longer.

9.15.4 DISCOUNT RATE

Discount rates can vary over time, based on inflation and interest rates, and the opportunity cost of capital (OCC). The time to use a discount rate is when you want to calculate the present value (PV) of a future value, to convert the amount to equivalent current dollars. The US Office of Management and Budget (OMB) publishes a memorandum every year on discount rates to be used in cost-benefit analysis for federal programs. The memo goes to the heads of federal departments and agencies. The published OMB "real" discount rate for 2015 is .4% for a 5-year project time horizon ("Discount Rates for OMB Circular No. A-94," Memorandum M-12-06, January 21, 2015, at www.whitehouse.gov/omb). This takes into account the projected rates for inflation and interest.

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
0.0	0.4	0.7	1.1	1.7	2.0

Figure 15. 2015 Discount Rates for OMB Circular A-94.
Source: Executive Office of the President (Jan 21, 2015)

9.15.5 NET PRESENT VALUE

The Net Present Value (NPV) is the difference between the present value of benefits and the present value of costs. The future stream of benefits and costs is discounted in this calculation using the discount rate, which was previously discussed. The following equation and factors was used for this study:

$$NPV = \sum [(B_t - C_t) / (1 + r)^t]$$

Notation: B = Benefits; C = Costs; r = discount rate; t = time period. The summation ∑ in the equation above is from t = 0 (the initial start-up of the program) to t = n (the final year of the program).

9.15.6 SENSITIVITY ANALYSIS

By changing the time horizon and the discount rate in the NPV equation, different results will occur. Depending on the magnitude of changes to these numbers, the variation in results can be fairly substantial. Also, the benefits can be increased by researching more use cases and quantifying more value, or they can be factored down by applying or increasing probability factors to their likelihood. Overall, a conservative but realistic posture was taken when performing cost-benefit analysis for this study; and additional sensitivity analysis can be performed by the state to validate or change the choice of variables.

9.15.7 RETURN ON INVESTMENT CALCULATION

The Return on Investment (ROI) for a given financial alternative is a ratio that indicates whether the investment results in more benefits than costs. For a public good, the ROI result should be greater than zero for a program to be economically attractive from a Pareto improvement standpoint. A sub-zero ratio may not automatically "kill" a project, because it may result in a required capability that does not currently exist. Not all government functions are required to have a positive ROI as they are in the business world, given that government is required to provide certain services and protection to the public.

The formula for calculating the ROI, using the CBA results for NPV as inputs, is:

$$\frac{\text{Discounted Benefits - Discounted Costs}}{\text{Discounted Costs}}$$

9.15.8 OPPORTUNITY COST ANALYSIS

Since CBA is an application of economic allocation theory, the opportunity cost of using resources for statewide digital parcel data instead of something else is a question about alternatives – i.e., "what are the costs of implementing one policy initiative vs. another?" If alternative uses were to be compared, evaluating their estimated ROIs would be one basis for comparison.

9.16 REFERENCES

ROI and CBA are briefly explained in the tutorial accompanying the Strategic and Business Planning Guidelines (FGDC/NSGIC, c. 2006) entitled "Economic Justification: Measuring Return on Investment (ROI) and Cost Benefit Analysis". A more in-depth explanation is included in the ROI Workbook (FGDC/GITA/AWWA, c. 2007), entitled "Building a Business Case for Geospatial Information Technology." Another reference, developed with support from the Library of Congress for building a business case for digital geospatial data preservation, is the "Geoarchiving Comprehensive Cost-Benefit Analysis Guidance," (December 2011). Further details on CBA are provided in the federal OMB Circular A-94 (RE: Executive Order No. 12291, c. 1992), entitled "Guidelines and Discount Rates for Cost-benefit Analysis of Federal Programs." There are also a number of textbooks on CBA that were referenced during this study, including: Boardman et. al., Cost-Benefit Analysis (Prentice Hall 2011); Brent, Applied Cost-Benefit Analysis (Elgan Publishers, 2006); and Mishan, Cost-Benefit Analysis (Praeger Publishers, 1976). In addition, the King County Study by Richard Zerbe et. al., "An Analysis of Benefits from Use of GIS by King County, Washington" (Zerbe & Associates, 2012) was reviewed.